

MAG REGIONAL FREEWAY BOTTLENECK STUDY

PRELIMINARY DRAFT WORKING PAPER FOR:

TASK 6 - BOTTLENECK ANALYSIS WORKING PAPER

TASK 7 - BOTTLENECK IMPROVEMENT SOLUTIONS

TASK 8 - BOTTLENECK IMPROVEMENTS BENEFITS

Part 1

**Draft Date:
October 10, 2002**

Submitted to:
THE MARICOPA ASSOCIATION OF GOVERNMENTS

Prepared by:



OLSSON ASSOCIATES

Draft

BOTTLENECK ANALYSIS WORKING PAPER

Background

During the fall of 2001, Skycomp, Inc. conducted an aerial survey of the regional freeway system and identified freeways that they found congested. The sixteen congested segments identified by Skycomp are graphically depicted in Figures 1 through 3 at the end of this section. Figure 1 depicts morning peak bottleneck areas; Figure 2 depicts afternoon peak bottleneck areas, and freeway mainline crash rates for the year 2000 are shown in Figure 3.

Using the freeway operations model FREQ and traffic data collected during 2001, Catalina Engineering evaluated bottlenecks on the freeway system and identified and evaluated possible solutions to the bottleneck problems.

The purpose of this working paper is, thus, to present the following:

1. The analysis of the bottleneck areas within the 16 congested segments identified on the regional freeway system. (Task 6)
2. The identification of bottleneck improvement solutions. (Task 7)
3. The benefits to the freeway system that would result from implementing the improvements. (Task 8)

The working paper presents a summary of the bottleneck analysis results, recommended improvement projects, benefits of the improvements, and a discussion on the ranking of bottleneck projects. The appendix includes the full FREQ analysis results and additional information on each of the congested segments accumulated from the aerial observations, including Level of Service results based upon freeway densities, and crash analysis.

Analysis Methodology

The bottleneck analysis process involved inputting roadway geometrics and traffic volumes (for each 15-minute period on all ramps and the mainline for a four-hour peak period) into the FREQ model. The results were then reviewed and solutions to the bottlenecks were identified, coded into the FREQ model, and evaluated.

A listing of projects that have been identified as part of the bottleneck analysis and the benefits that would result from the improvement is provided in Table 1. During the analysis, it was found that ADOT is working on many of these projects. Therefore, a project status column is included in the table indicating which projects are already in the design/construction process. If known, the year that the project will be constructed is indicated.

The analysis also revealed that in some cases, congestion is caused by overall corridor capacity deficiencies, i.e., not enough lanes to accommodate the traffic volume, rather than bottlenecks. Thus, bottleneck projects have not been identified for each of the 16 segments evaluated.

In addition to the projects presented in Table 1, ADOT is working on two projects that address bottleneck issues:

1. The HOV bypass striping that is located at 40 metered on-ramp locations is being converted to two-lane metered on-ramps.
2. I-10 through the deck-park tunnel is being re-striped to provide a 4+1+A (four general purpose lanes, one HOV lane, and an auxiliary lane) cross section.

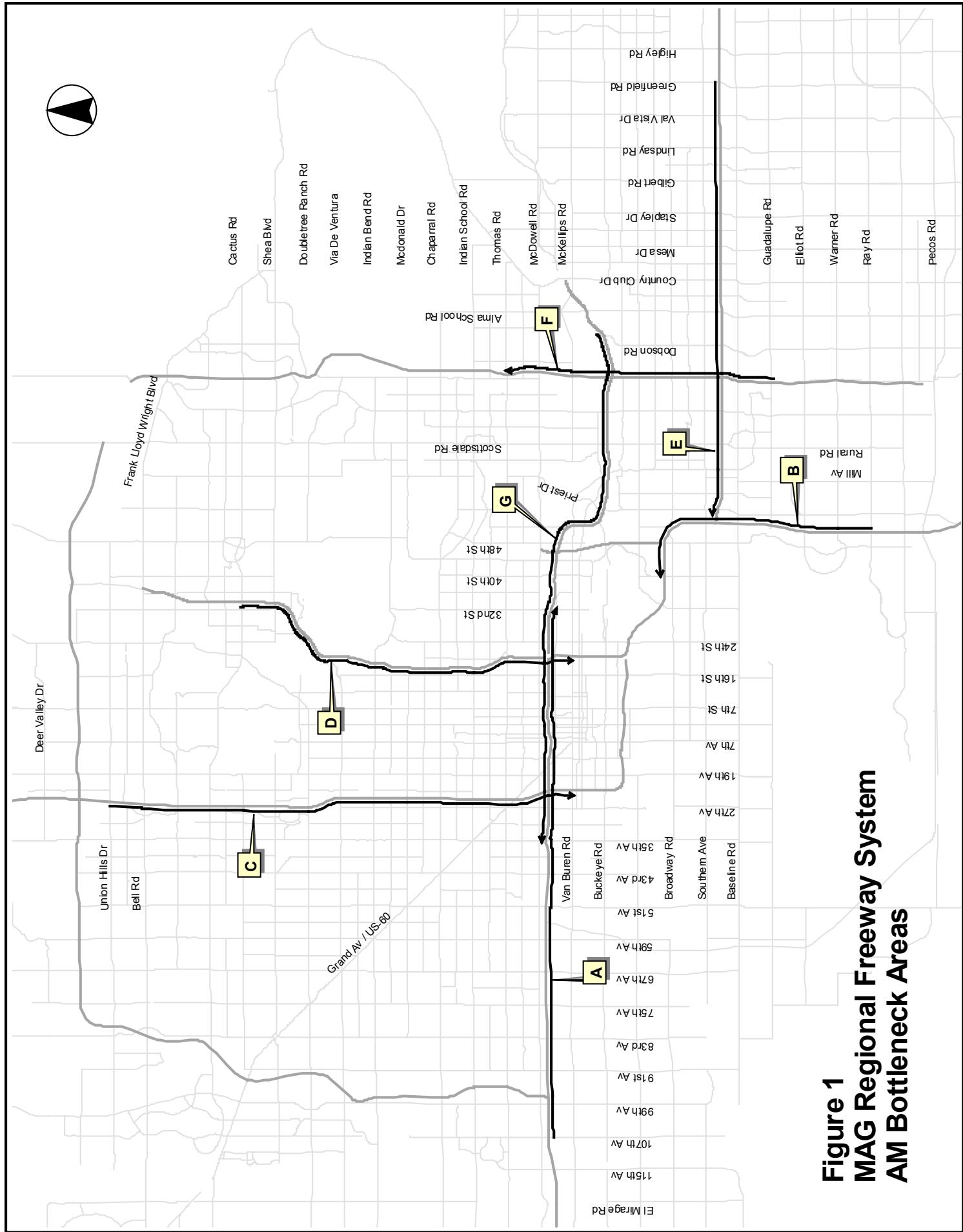
Throughout the FREQ bottleneck analysis, it was found that system-wide ramp metering will be required to realize the full benefit of metering. While ramp metering will not eliminate major bottlenecks, it can reduce the queuing and congestion that routinely occur during peak traffic periods.

Table 1. Bottleneck Projects

Freeway Segment	Project	Benefits	ADOT Project Status (as of July 2002)	Comments
A: I-10 Eastbound: 99 th Avenue to 32 nd Street	Widen EB I-10 from Loop 101 to 83 rd Avenue to a 5+1+A section and from 83 rd Avenue to 59 th Avenue to a 4+1+A section	Decreases morning peak travel time by 2,555 passenger-hours (13%)	Under design	With these improvements, bottlenecks will still remain on I-10 at 43 rd Avenue and 19 th Avenue. However, it is recommended that, since these bottlenecks will serve to meter traffic approaching the central Phoenix area, that changes at these two locations not be made.
B: I-10 Westbound: Ray Road to 40 th Street	Construct WB collector-distributor road between Baseline Road and SR-153 (40 th Street)	Decreases morning peak hour travel time by 10,551 passenger-hours (30%)	Under study – 2008 construction	
C: I-17 Southbound: Union Hills Drive to Van Buren Street	Add auxiliary lanes between Union Hills Drive and Peoria Avenue and between McDowell Road and Thomas Road	Decreases morning peak hour travel time by 1,384 passenger-hours (6%)	Under design – 2005 construction	Additional capacity is needed in the I-17 corridor to relieve congestion.
D: SR-51 Southbound: Cactus Road to Van Buren Street	Add auxiliary lanes between Glendale Avenue and Bethany Home Road and between Indian School Road and Thomas Road	Decreases morning peak hour travel time by 2,686 passenger-hours (8%)		The planned addition of an HOV lane in the SR-51 corridor will reduce freeway travel time by 15%.
E: US-60 Westbound: Greenfield Road to I-10	None			The US-60 corridor is currently under construction. The analysis indicates that with the completed construction, congestion will still remain between Loop 101 and I-10.
F: Loop 101 Northbound: Guadalupe Road to Thomas Road	Add auxiliary lanes between McKellips Road and Thomas Road	Decreases morning peak hour travel time by 3,402 passenger-hours (10%)	Under design – 2004 construction	Congestion is created by six on-ramps within a 3.5-mile stretch.
G: Loop 202 Westbound: Dobson Road to 35 th Avenue (on I-10)	None			Improving the bottlenecks at the two system interchange on this segment would result in traffic reaching the congested central Phoenix quicker, thus exacerbating that problem. Therefore, no bottleneck improvements are recommended.
H: I-10 Eastbound: 24 th Street to Baseline Road	Construct EB collector-distributor road between SR-143 and Baseline Road	Decreases evening peak hour travel time by 4,671 passenger-hours (37%)	Under study – 2008 construction	

Freeway Segment	Project	Benefits	ADOT Project Status (as of July 2002)	Comments
I: I-10 Westbound: 40 th Street (on Loop 202) to 99 th Avenue	Construct additional general purpose lane and auxiliary lanes between 35 th Avenue and 67 th Avenue	Decreases evening peak hour travel time by 1,203 passenger-hours (4%)		
J: I-17 Northbound: Van Buren Street to Bell Road	None			
K: SR-51 Northbound: Van Buren Street (on I-10) to Northern Avenue	Construct auxiliary lane from Glendale Avenue to Northern Avenue, including a two-lane on-ramp at Glendale Avenue	Decreases evening peak hour travel time by 2,456 passenger-hours (11%)		
L: US-60 Eastbound: I-10 to Greenfield Road	None			The US-60 corridor is currently under construction. The analysis indicates that with the completed construction, congestion will still remain between I-10 and Mill Avenue.
M: SR-143 Southbound: University Drive to I-10	None			
N: Loop 101 Southbound: Via de Ventura to Guadalupe Road	Add auxiliary lanes from Thomas Road to McKellips Road and add a third lane across the US-60 interchange.	Decreases evening peak hour travel time by 1,903 passenger-hours (26%)		
O: Loop 101 Westbound: I-17 to 51 st Avenue	Add a fourth general purpose lane from 35 th Avenue to 51 st Avenue	Decreases evening peak hour travel time by 515 passenger-hours (9%)		
P: Loop 202 Eastbound: 27 th Avenue to Dobson Road	Add auxiliary lanes between Mill Avenue and McClintock Drive and make the Loop 101 off-ramp a mandatory two-lane exit.	Decreases evening peak hour travel time by 4,100 passenger-hours (8%)	Mandatory two-lane off-ramp at Loop 101 in scoping	Adding a third general purpose lane connecting I-10 to Loop 202 in addition to recommended bottleneck projects would reduce travel time by 6,752 passenger-hours (14%)





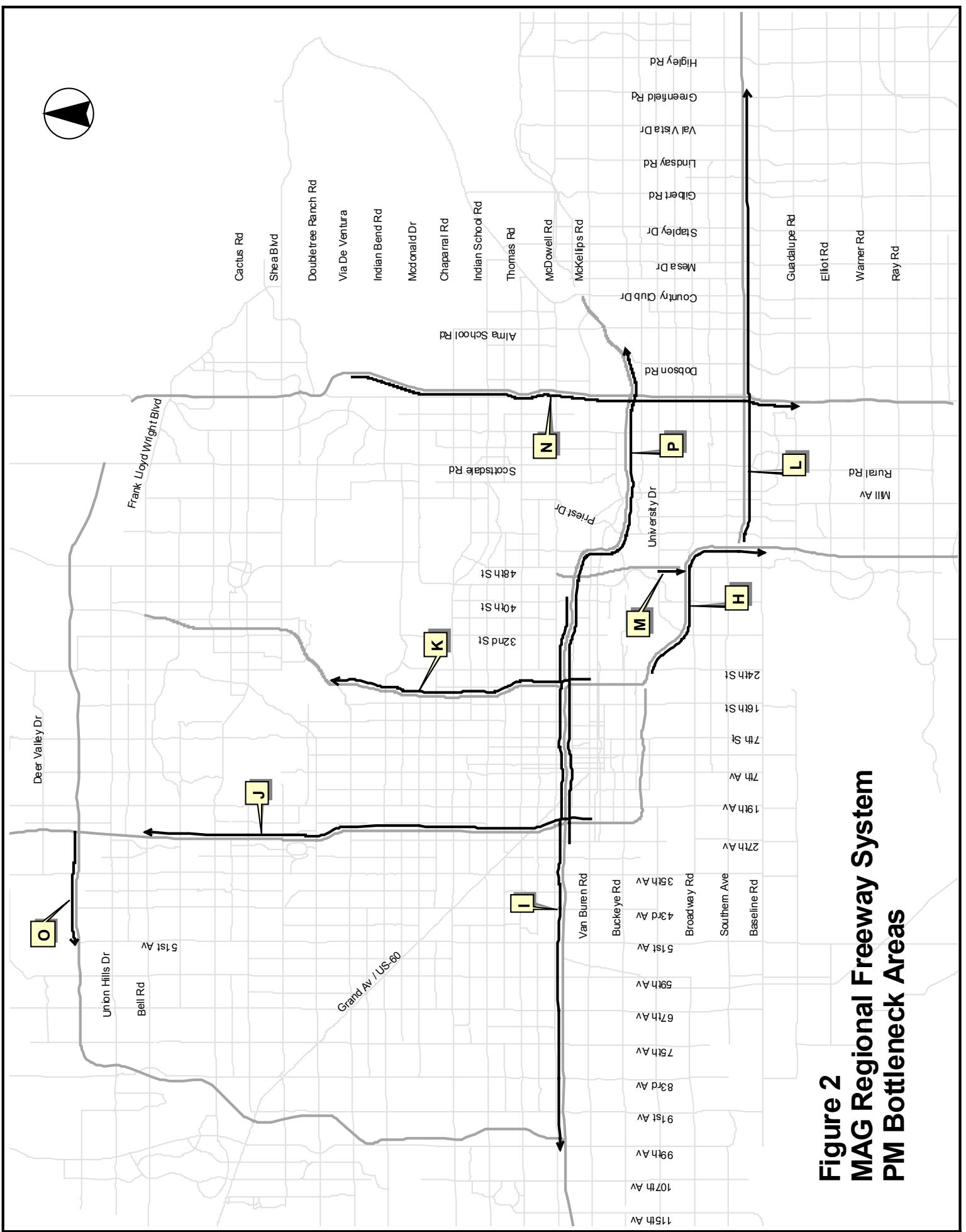


Figure 2
MAG Regional Freeway System
PM Bottleneck Areas

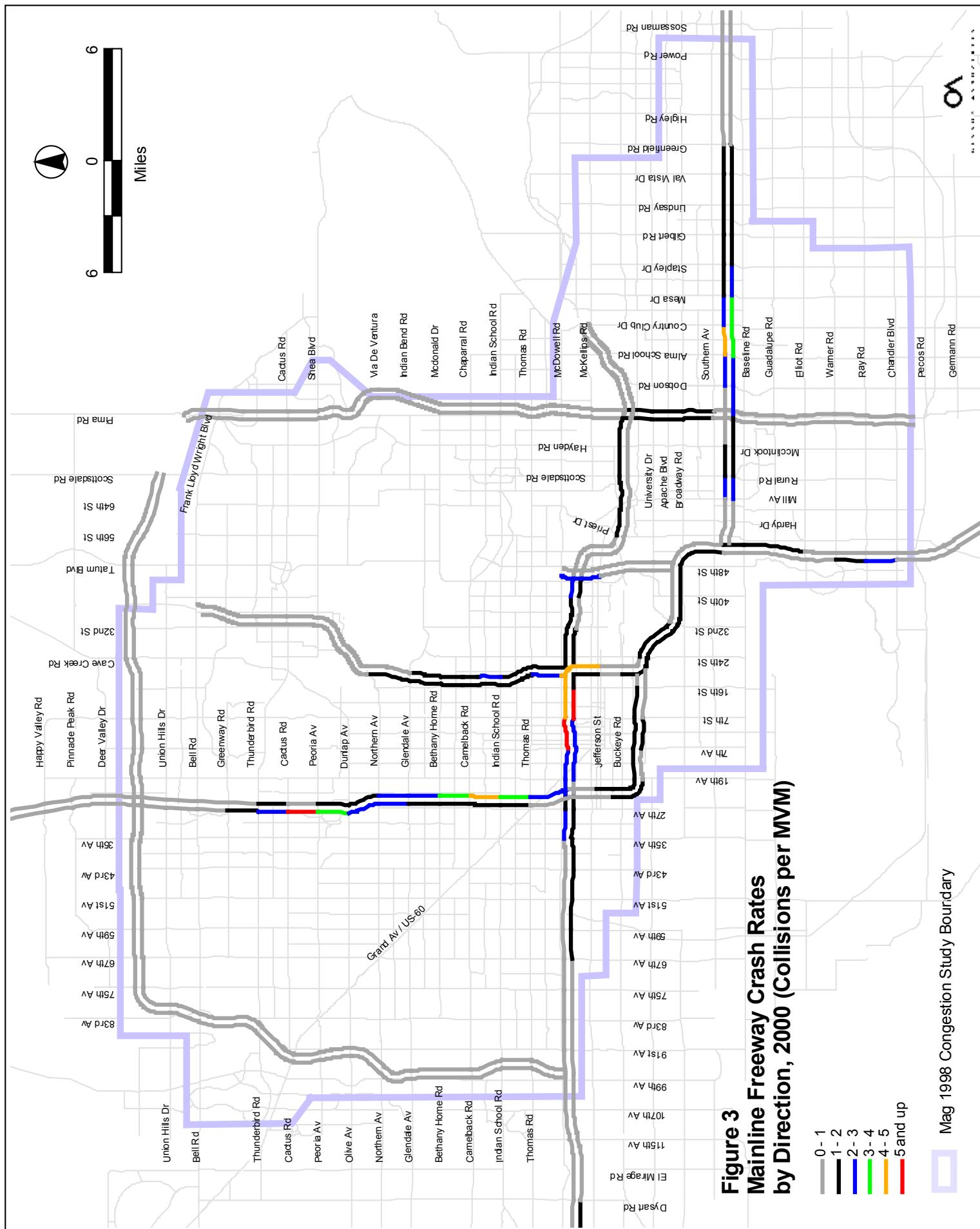


Figure 3
Mainline Freeway Crash Rates
by Direction, 2000 (Collisions per MVM)

APPENDIX A

APPENDIX A
TABLE OF CONTENTS

SEGMENT LOCATION

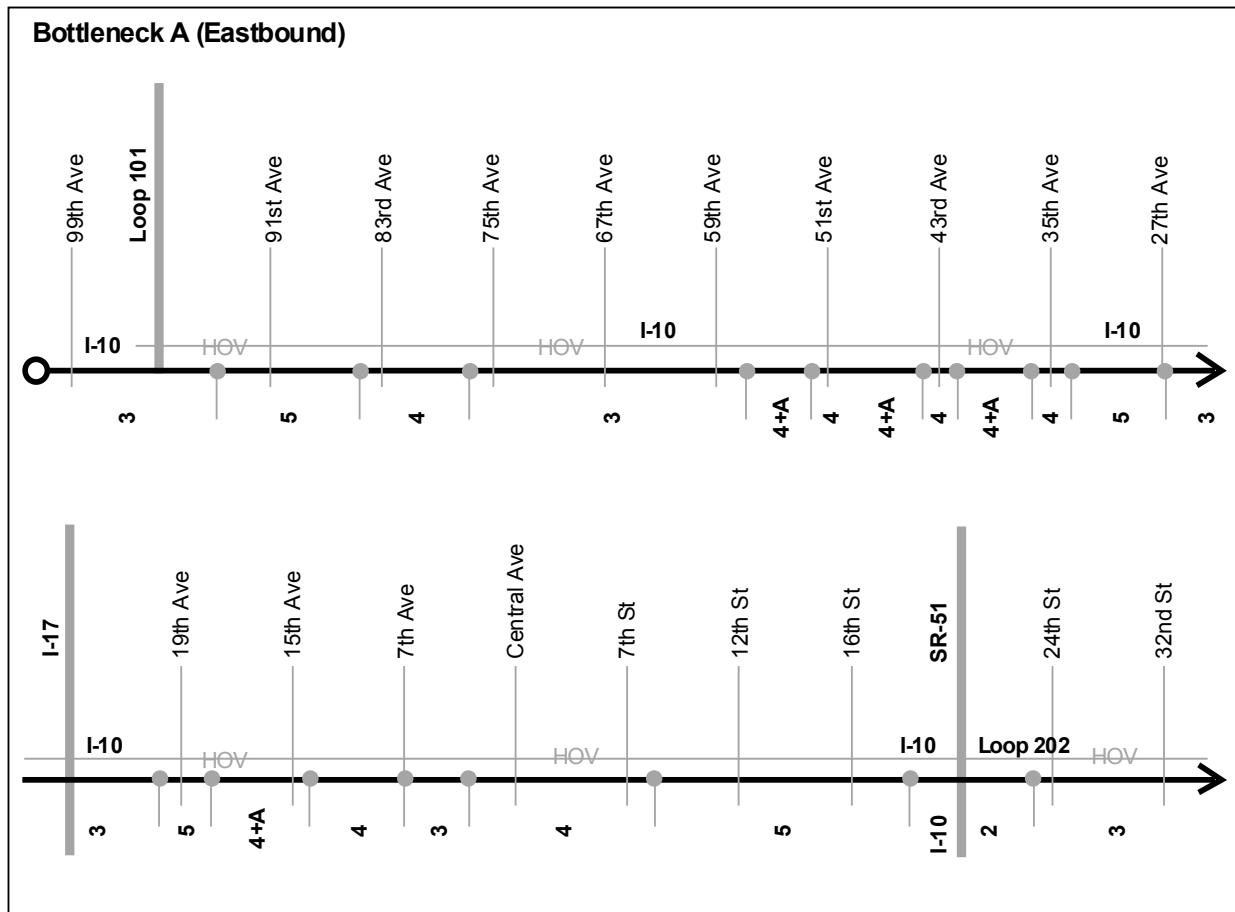
- A I-10 EASTBOUND:** 99th Avenue to 32nd Street (on Loop 202) – AM Peak
- B I-10 WESTBOUND:** Ray Road to 40th Street – AM Peak
- C I-17 SOUTHBOUND:** Union Hills Drive to Van Buren Street – AM Peak
- D SR-51 SOUTHBOUND:** Cactus Road to Van Buren Street – AM Peak
- E US-60 WESTBOUND:** Greenfield Road to I-10 – AM Peak
- F LOOP 101 NORTHBOUND:** Guadalupe Road to Thomas Road – AM Peak
- G LOOP 202 WESTBOUND:** Dobson Road to 35th Avenue (on I-10) – AM Peak
- H I -10 EASTBOUND:** 24th Street to Baseline Road – PM Peak
- I I-10 WESTBOUND:** 40th Street (on Loop 202) to 99th Avenue – PM Peak
- J I-17 NORTHBOUND:** Van Buren Street (on I-10) to Bell Road – PM Peak
- K SR-51 NORTHBOUND:** Van Buren Street (on I-10) to Northern Avenue – PM Peak
- L US-60 EASTBOUND:** I-10 to Greenfield Road – PM Peak
- M SR-143 SOUTHBOUND:** University Drive to I-10 – PM Peak
- N LOOP 101 SOUTHBOUND:** Via de Ventura to Guadalupe Road – PM Peak
- O LOOP 101 WESTBOUND:** I-17 to 51st Avenue – PM Peak
- P LOOP 202 EASTBOUND:** 27th Avenue (on I-10) to Dobson Road – PM Peak

SEGMENT A
I-10 EASTBOUND: 99TH AVENUE TO 32ND STREET (ON LOOP 202)
MORNING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates lane numbers along the A bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along this bottleneck segment reaches a maximum of 259,000 vehicles (vpd) at the intersection of I-10 and 7th St. The volume at this location during the AM peak hour is 15,500 for General Purpose lanes and 2,400 for HOV lanes. These combined peak hour volumes represent 6.9% of the total daily volume.

Eastbound Traffic Volumes:

The volumes shown in the table below represent eastbound counts along the A bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes

TRAFFIC VOLUMES

Location	AM Peak Hour Total Volume	AM Peak Hour GP Volume	AM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
I-10 / 83 rd Av	6,400	5,500	900	6.6%	4.9%
I-10 / 35 th Av	9,600	8,100	1,500	8.5%	4.4%
I-10 / 7 th Av	8,900	7,400	1,500	7.2%	-----
I-10 / 7 th St	8,000	6,800	1,200	6.6%	1.7%
I-10 / 40 th St	6,300	6,300	600	6.6%	1.0%

CRASH DATA – COLLISION TYPE

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	1008	1.73	699	152	123	34
1999	958	1.55	604	181	135	38
2000	1133	1.74	760	210	128	35
Total	3099	1.67	2063	543	386	107

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	1008	752	254	2	71
1999	958	686	267	5	93
2000	1133	806	326	1	98
Total	3099	2244	847	8	262



SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During the peak period, eastbound congestion was found on I-10 between 91st Avenue and 59th Avenue; average estimated speeds along this segment ranged from approximately 20 to 40 mph. Factors contributing to the congestion were 1) lane drop [5 lanes to 4] at 83rd Avenue and 2) the lane drop [4 lanes to 3] at 75th Avenue.

On some days but not others, a short zone of eastbound congestion was found on I-10 between I-17 and 7th Avenue; when congested, average estimated speeds along this segment ranged from approximately 40 to 50 mph. Congestion appeared to be caused or exacerbated by the lane drops (5 lanes to 4 and 4 lanes to 3) in the vicinity of 7th Avenue.

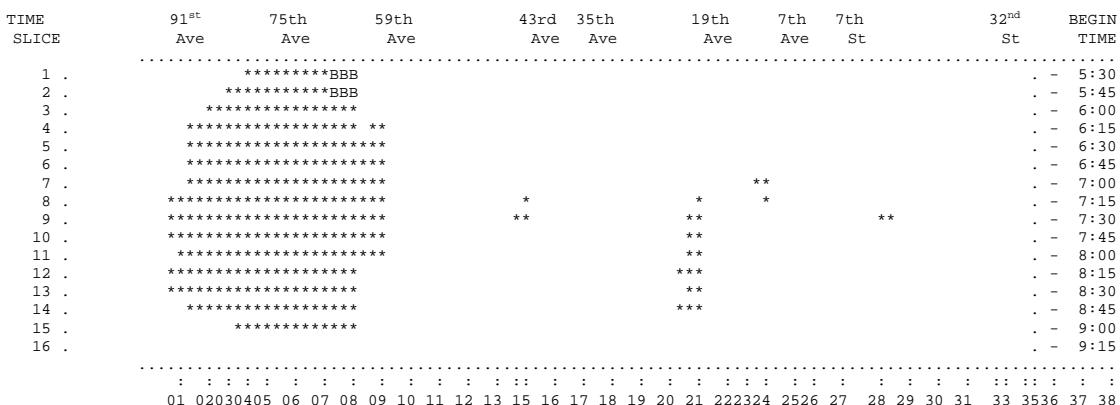
Density Data: Level of Service F (density greater than 45 vehicles per lane mile) between 83rd Avenue and 59th Avenue between 6:00 and 6:30 am; between 91st Avenue and 59th Avenue between 6:30 and 7:30 am; and between 75th Avenue and 59th Avenue between 7:30 and 8:30 am.

FREQ ANALYSIS

Segment A: I-10 EB; 99th Avenue to 32nd Street; 5:30 to 9:30 am

Existing Conditions: Existing bottlenecks are occurring at 59th Avenue, 43rd Avenue, 19th Avenue and 7th Avenue.

Queue Diagram of Existing Conditions for Segment A:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

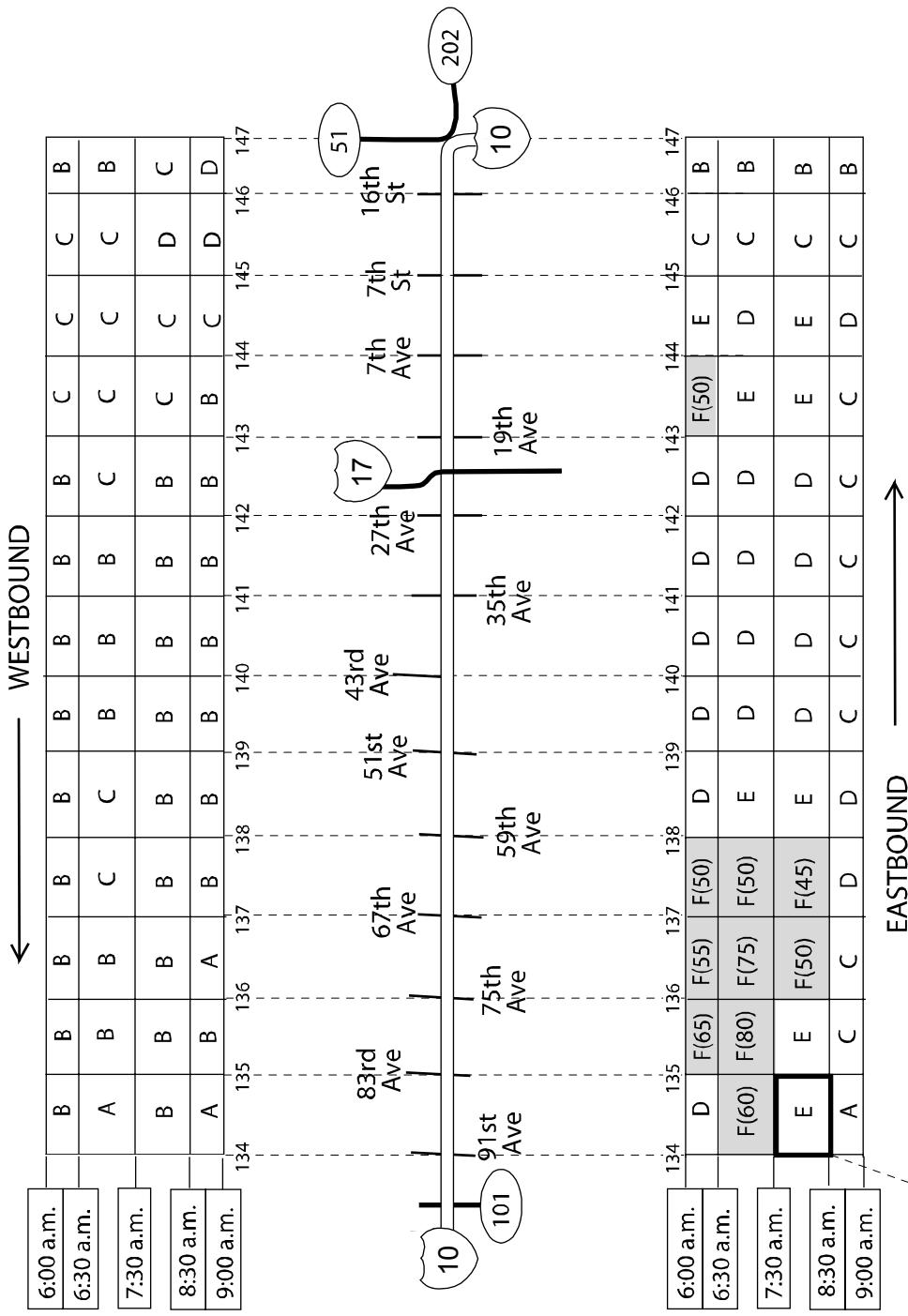
B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).



I-10

(Between 91st Ave & Loop 202 / SR 51)
Morning - Fall 2001



These level-of-service ratings represent the mathematical average of densities, which varied during this hour (congested/not congested); when congested, densities ranged widely, between 90 and 45 pcplpm with corresponding speed estimates of 20 to 50 mph.

LEVEL-OF-SERVICE LEGEND:

LIGHT	MODERATE	HEAVY	CONGESTED	SEVERE
A	B	C	D	F

0 10 20 30 45 65
Density scale (cars per lane-mile)
Note: F(60) in the tables means level of service "F" with density = 60 pcplpm

Alternative 1: Add a lane from 75th Avenue on-ramp to 59th Avenue on-ramp to increase cross section to 4 lanes, matching east of 59th Avenue

Result: This alternative eliminates the 59th Avenue bottleneck, but increases congestion at the 43rd Avenue and 19th Avenue bottlenecks as the demand at the 59th Avenue bottleneck moves downstream. Overall, freeway travel time decreases 13%.

Queue Diagram of Alternative 1 for Segment A:

TIME SLICE	91 st Ave	75th Ave	59th Ave	43rd Ave	35th Ave	19th Ave	7th Ave	7th St	32 nd St	BEGIN TIME																								
1 .				****	***					. - 5:30																								
2 .				*****						. - 5:45																								
3 .				****						. - 6:00																								
4 .				*****		*				. - 6:15																								
5 .				*****						. - 6:30																								
6 .				*****						. - 6:45																								
7 .				***						. - 7:00																								
8 .				*****			***			. - 7:15																								
9 .				*****		*	**			. - 7:30																								
10 .				*****		**		**		. - 7:45																								
11 .				*****		**				. - 8:00																								
12 .				*****		****				. - 8:15																								
13 .				*		*****				. - 8:30																								
14 .						*****				. - 8:45																								
15 .										. - 9:00																								
16 .										. - 9:15																								
:	:	:	:	:	:	:	:	:	:	:																								
01	02	03	04	05	06	07	08	09	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	33	35	36	37	38

Alternative 2: Add ramp metering, optimizing between 400 and 900 vehicles per hour.

Result: This alternative eliminates congestion at existing bottlenecks, but causes long queues and delays at on-ramps. Overall freeway travel time increases slightly.

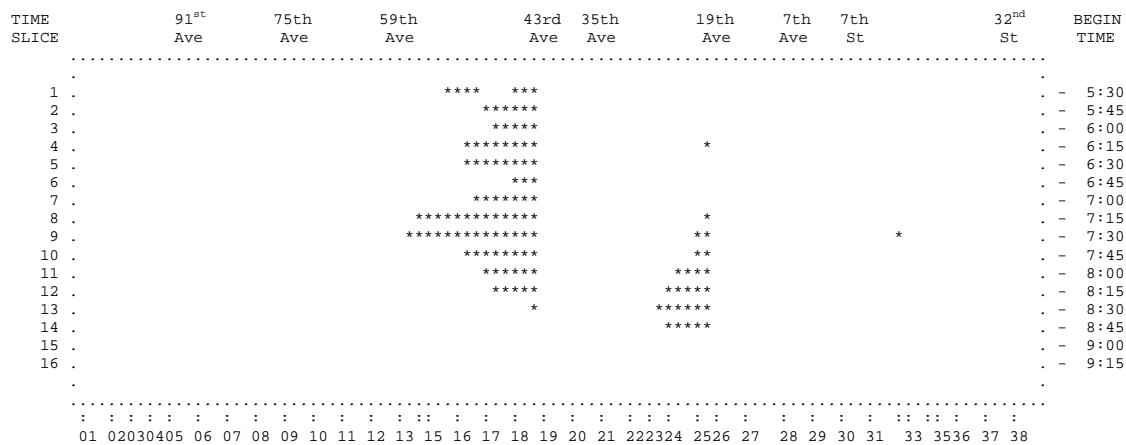
Queue Diagram of Alternative 2 for Segment A:

TIME SLICE	91 st Ave	75th Ave	59th Ave	43rd Ave	35th Ave	19th Ave	7th Ave	7th St	32 nd St	BEGIN TIME																								
1 .										. - 5:30																								
2 .										. - 5:45																								
3 .										. - 6:00																								
4 .			*							. - 6:15																								
5 .			*							. - 6:30																								
6 .			*							. - 6:45																								
7 .										. - 7:00																								
8 .										. - 7:15																								
9 .										. - 7:30																								
10 .				*						. - 7:45																								
11 .										. - 8:00																								
12 .										. - 8:15																								
13 .										. - 8:30																								
14 .										. - 8:45																								
15 .										. - 9:00																								
16 .										. - 9:15																								
:	:	:	:	:	:	:	:	:	:	:																								
01	02	03	04	05	06	07	08	09	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	33	35	36	37	38

Alternative 3: Widen the cross-section to 5+1(HOV)+A(auxiliary) from Loop 101 on-ramp to 83rd Avenue and 4+1+A from 83rd Avenue to 59th Avenue. Also add a lane from 7th Avenue to 7th Street to get a 4+1+A cross-section with a lane drop at the 7th Street off-ramp.

Result: This alternative eliminates the 59th Avenue bottleneck, but increases congestion at the 43rd Avenue and 19th Avenue bottlenecks. Overall travel time decreases 13%, the same as for Alternative 1.

Queue Diagram of Alternative 3 for Segment A:



ANALYSIS SUMMARY – SEGMENT A

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	12092	7535	19627	42.6
Alternative 1	9498	7723	17221	54.3
Alternative 2	7815	12156	19972	64.6
Alternative 3	9350	7723	17072	55.1

Conclusions/Recommendations:

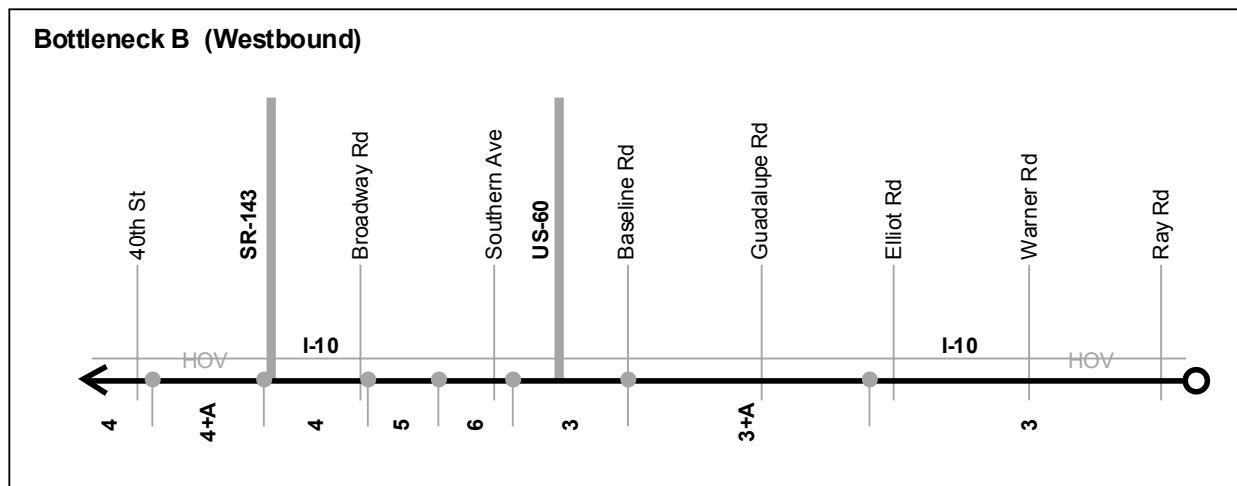
1. The addition of general purpose and auxiliary lanes from Loop 101 to 59th Avenue will significantly reduce existing congestion at the existing bottleneck at 59th Avenue, however, this improvement will also increase demand downstream, creating congestion at 43rd Avenue and 19th Avenue. Increasing the capacity of these two bottlenecks, particularly 19th Avenue, will create added congestion within the downtown section of I-10. As such, keeping the bottlenecks at 43rd Avenue and 19th Avenue in place should be considered as a way to meter traffic demand downstream.
2. Widen the section of I-10 from Loop 101 to 83rd Avenue to a 5+1+A eastbound cross section.
3. Widen the section of I-10 from 83rd Avenue to 59th Avenue to a 4+1+A eastbound cross section.
4. Ramp metering currently exists at most of the on-ramps along the section of I-10 west of I-17. Reducing metering rates accompanied by increased ramp storage, and adding meters to currently un-metered ramps, including the SR 101 to I-10 connection, should be considered.

SEGMENT B
I-10 WESTBOUND: RAY ROAD TO 40TH STREET
MORNING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the B bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the B bottleneck segment reaches a maximum of 240,000 vehicles (vpd) at the intersection of I-10 and Broadway Rd (the “Broadway Curve”). The volume at this location during the AM peak hour is 18,200, which represents 7.5% of the total daily volume.

Westbound Traffic Volumes:

The volumes shown in the table below represent westbound counts along the B bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	AM Peak Hour Total Volume	AM Peak Hour GP Volume	AM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
I-10 / Ray Rd	5,900	-----	-----	8.3%	-----
I-17 / Warner Rd	6,000	-----	-----	8.9%	2.5%
I-17 / Guadalupe Rd	7,700	-----	-----	7.7%	-----
I-17 / Broadway Rd	12,000	-----	-----	9.8%	-----
I-17 / 32nd St	9,700	-----	-----	9.3%	3.4%

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	255	1.04	153	39	48	15
1999	277	1.08	167	45	48	17
2000	319	1.18	189	61	53	16
Total	851	1.10	509	145	149	48

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	255	183	70	2	26
1999	277	202	75	0	28
2000	319	229	90	0	38
Total	851	614	235	2	92

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During most observations, an extended zone of northbound congestion was found in I-10 between Ray Road and Southern Avenue; average estimated speeds typically range from approximately 10 to 30 mph. Factors contributing to the congestion were 1) the lane drop [4 lanes to 3] at Baseline Road and 2) traffic entering at US-60. Traffic flow typically improved north of Southern Avenue, where the road widened from 3 to 5 lanes.

During the peak period, northbound congestion was found in the weaving lanes (separated by Jersey barrier) between Baseline Road and US-60: when congested, approximately 40 to 60 vehicles were queued on the ramp to I-10 (one lane).

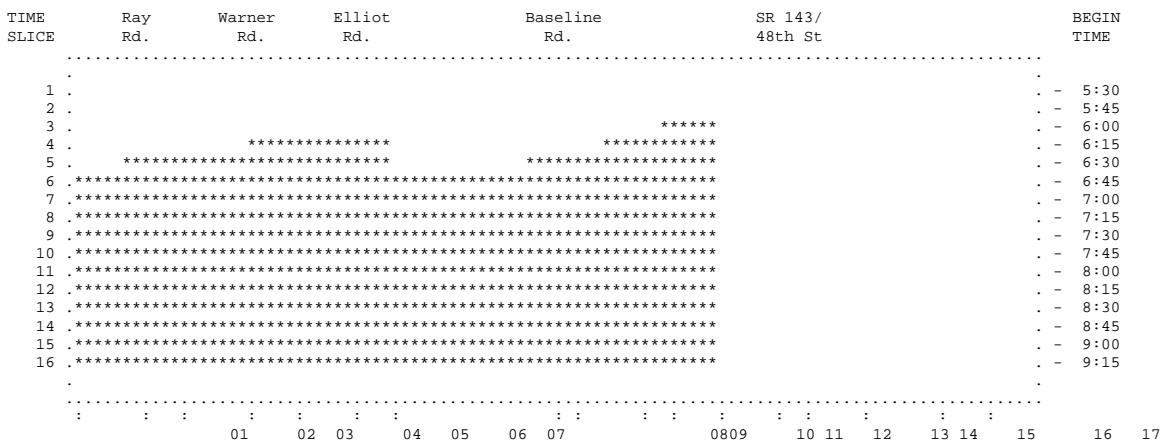
Density Data: (no data collected after 9:00 am) Level of Service F (density greater than 45 vehicles per lane-mile) between Southern Avenue and Ray Road between 6:30 and 9:00 am.

FREQ ANALYSIS

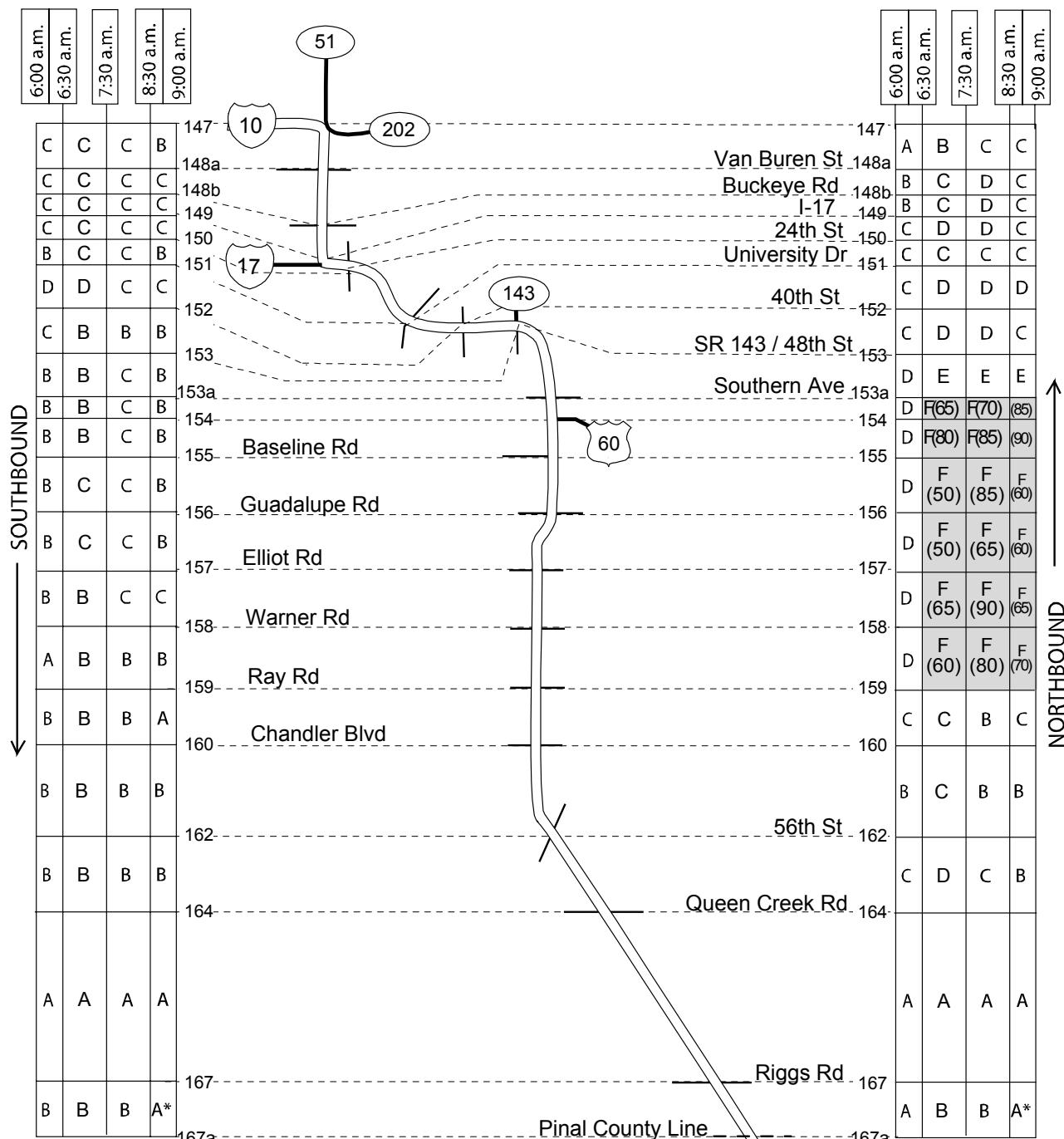
Segment B: I-10 WB; Ray Road to 40th Street; 5:30 to 9:30 AM

Existing Conditions: Existing bottlenecks are occurring at Elliot Road and Broadway Road. Congestion extends from Broadway Road to south of Ray Road. The bottleneck at Broadway Road is due to heavy merging and weaving between the I-10/US-60 junction and SR-143.

Queue Diagram of Existing Conditions for Segment B:



I-10
(Between Loop 202 / SR 51 & Chandler Blvd)
Morning - Fall 2001



* Projected Data

LEVEL-OF-SERVICE LEGEND:						
LIGHT	MODERATE	HEAVY	CONGESTED	SEVERE		
A	B	C	D	E	F	
0	10	20	30	45	65	

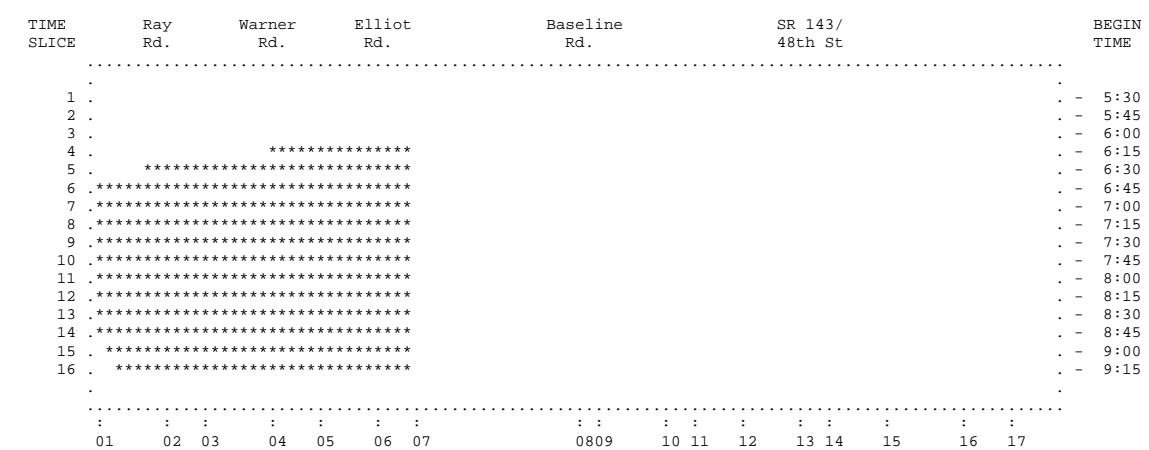
Density scale (cars per lane-mile)

Note: F (60) in the tables means level-of-service "F", with density = 60

Alternative 1: Add a collector-distributor road from Baseline Road to SR-143. The collector-distributor road will remove traffic headed to Broadway Road and SR-143 from the I-10/US-60 merge/weave area.

Result: This alternative eliminates the congestion at the Broadway Road bottleneck, however the bottleneck at Elliot Road remains. Overall freeway travel time decreases 26%.

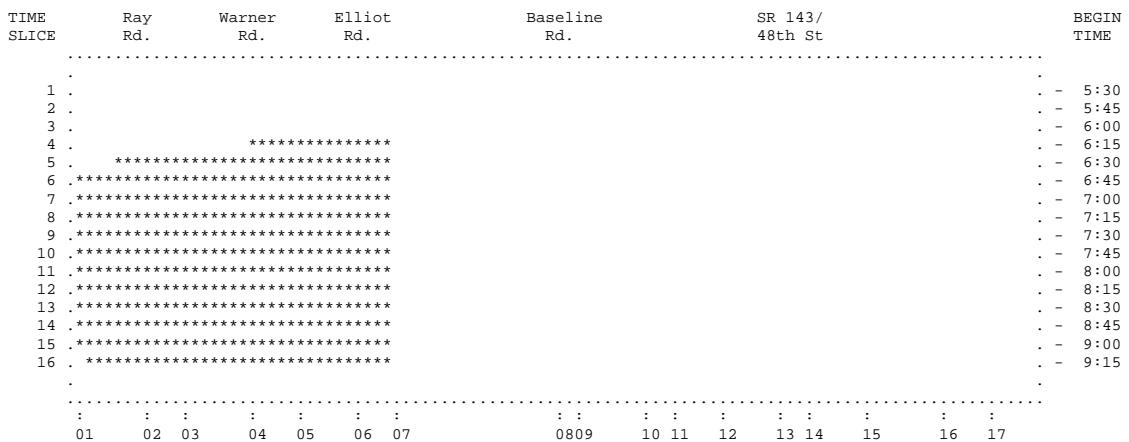
Queue Diagram of Alternative 1 for Segment B:



Alternative 2: Add a collector –distributor road from Baseline Road to 40th Street.

Result: Similar to the results of Alternative 1, this alternative eliminates the congestion at the Broadway Road bottleneck, but does not improve conditions at Elliot Road. Overall, freeway travel time decreases 30%.

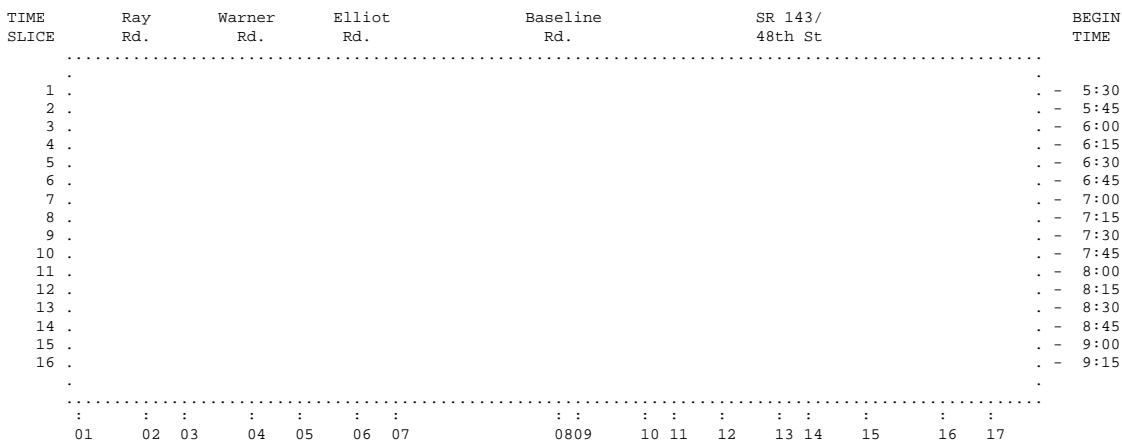
Queue Diagram of Alternative 2 for Segment B:



Alternative 3: Add ramp metering at 900 vehicles per hour. This does not include either of the collector-distributor road alternatives.

Result: This alternative eliminates congestion at both bottlenecks, but causes significant queues and delays at all on-ramps from Ray Road. Overall freeway travel time increases slightly, not including delays caused to arterial traffic at ramp junctions.

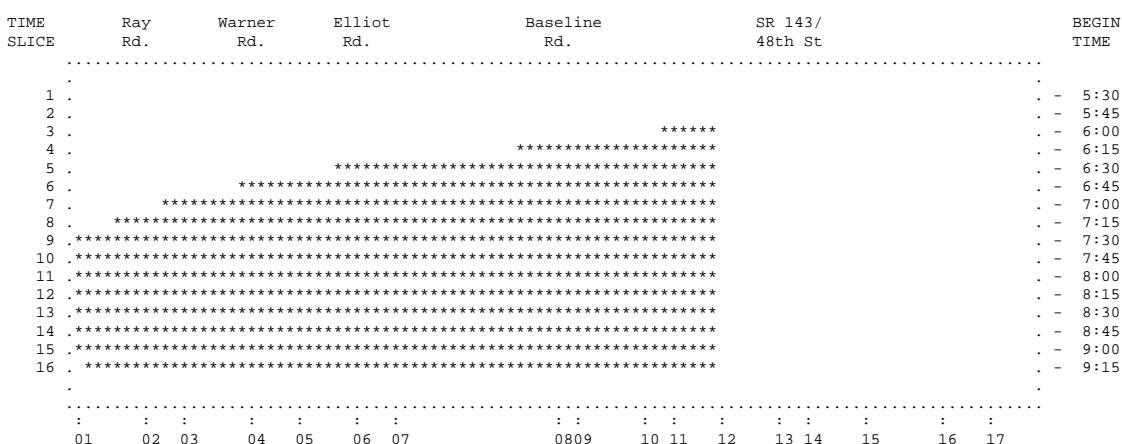
Queue Diagram of Alternative 3 for Segment B:



Alternative 4: Widen the mainline cross section to 4+1+A from Chandler Boulevard to the US-60 interchange. This alternative does not include either collector-distributor road option.

Result: This alternative reduces the congestion at Elliot Road, but congestion from the bottleneck at Broadway Road still extends south of Ray Road. Overall freeway travel time increases 5% since demand from Elliot Road moves downstream.

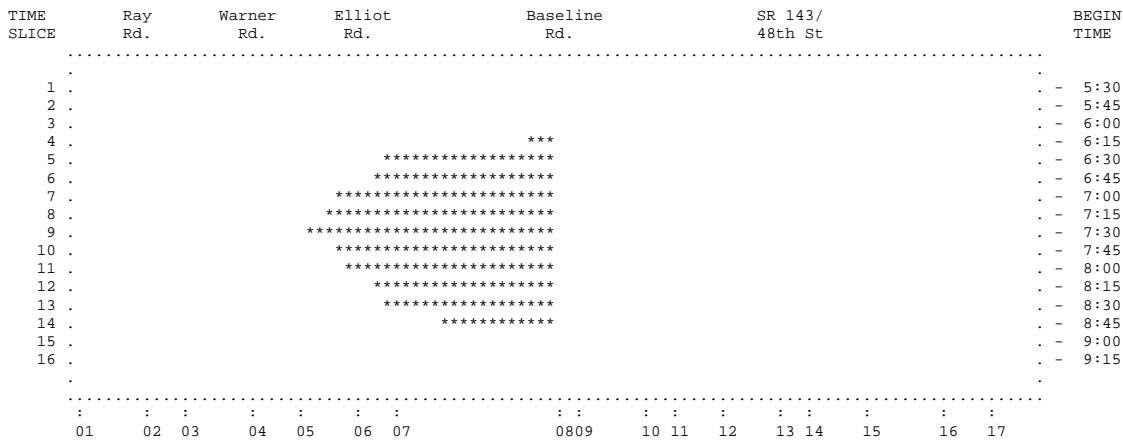
Queue Diagram of Alternative 4 for Segment B:



Alternative 5: Widen the mainline cross section to 4+1+A from Chandler Boulevard to the US-60 interchange. Also include the collector-distributor road from Baseline Road to the SR-143 interchange.

Result: This alternative eliminates congestion at the Elliot Road and Broadway Road bottlenecks, however a new bottleneck occurs at Baseline Road. Overall freeway travel time decreases 33%.

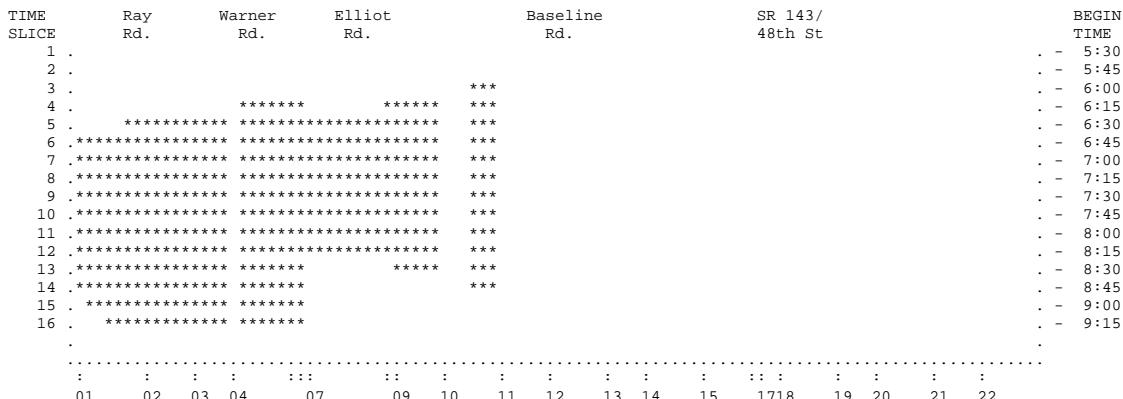
Queue Diagram of Alternative 5 for Segment B:



Alternative 6: This alternative addresses the impact of eliminating the existing bottleneck on WB US-60, which will increase demand at the WB I-10/US-60 junction. The analysis of this alternative assumed that the collector-distributor road from Baseline Road to SR-143 (Alt. 1) will be constructed on I-10.

Result: The higher volume of traffic entering I-10 from US-60 will result in higher overall travel time, however the majority of congestion will continue to be contained on the US-60 ramp as it is today. Overall, freeway travel time will be 30% lower than existing conditions, as compared to 45% lower if the bottleneck on US-60 is not relieved.

Queue Diagram of Alternative 6 for Segment B:



ANALYSIS SUMMARY – SEGMENT B

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	9639	23415	33055	23.9
Alternative 1	6651	17848	24499	31.5
Alternative 2	6979	15545	22524	32.2
Alternative 3	2879	30558	33437	67.4
Alternative 4	12022	22746	34768	19.8
Alternative 5	4445	17920	22364	51.8

Conclusions/Recommendations:

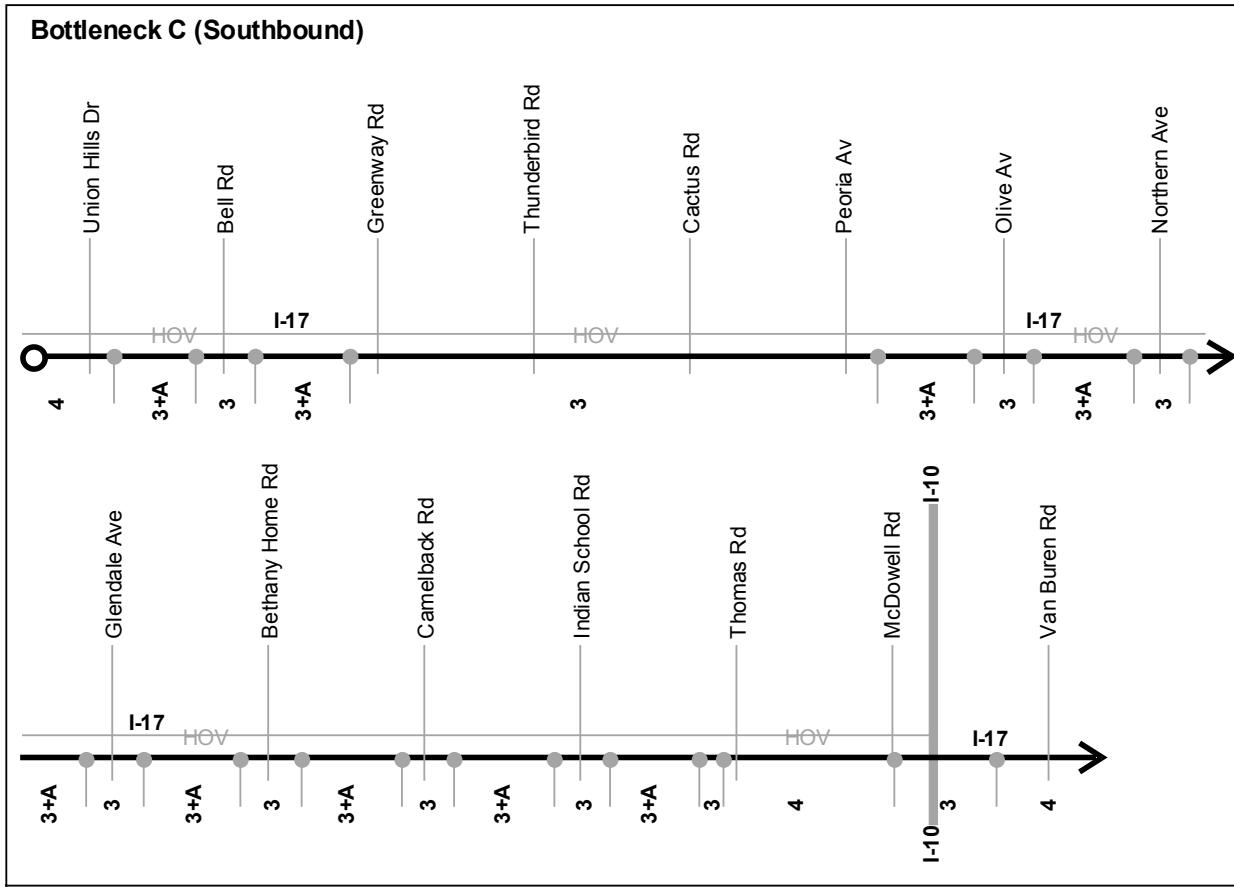
1. The addition of a collector-distributor road from Baseline Road to SR-143 will eliminate much of the merging/weaving at the I-10/US-60 interchange, thereby increasing the capacity of the segment between the interchange and SR-143. The on-going collector-distributor road study will provide a detailed assessment of the impacts on mainline traffic flow, collector-distributor road operations, and access.
2. Widening the section of I-10 from Chandler Boulevard to US-60 to 4+1+A will alleviate congestion at the Elliot Road bottleneck, however, the increased demand downstream will create congestion at Baseline Road. This improvement should be evaluated as part of the collector-distributor road study.
3. Ramp metering should be installed at all on-ramps east of the I-10/US-60 interchange. Additional ramp storage should be added, if possible, in order to allow for reduced metering rates. A systems approach should be taken towards developing and optimizing ramp metering rates at each ramp. A uniform rate (i.e.-900 vph) at each ramp will not provide optimum benefits to traffic flow.
4. Eliminating the bottlenecks on WB US-60, which currently limits the volume of traffic that enters I-10, will impact traffic flow on I-10. However, traffic on the US-60 ramp will experience the majority of the delay and ramp backups will likely occur.

SEGMENT C
I-17 SOUTHBOUND: UNION HILLS DRIVE TO VAN BUREN STREET
MORNING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates lane numbers along the C bottleneck segment. Lane numbers are shown below the black line. The letter "A" indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along this bottleneck segment reaches a maximum of 208,000 vehicles (vpd) at the intersection of I-17 and Indian School Rd. The volume at this location during the AM peak hour is 13,100 for General Purpose lanes and 1,400 for HOV lanes. These combined peak hour volumes represent 6.3 percent of the total daily volume.

Southbound Traffic Volumes:

The volumes shown in the table below represent southbound counts along the C bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	AM Peak Hour Total Volume	AM Peak Hour GP Volume	AM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
I-17 / Thunderbird Rd	6,700	5,800	900	7.3%	2.4%
I-17 / Peoria Av	7,100	-----	-----	6.9%	-----
I-17 / Glendale Av	8,000	6,500	1,500	7.6%	1.3%
I-17 / Highland Av	8,100	7,000	1,100	7.6%	1.6%
I-17 / Van Buren St	6,200	-----	-----	9.2%	-----

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	963	2.0	738	90	107	28
1999	869	1.77	623	107	111	28
2000	1161	2.31	828	165	137	31
Total	2993	2.03	2189	362	355	87

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	963	684	277	2	58
1999	869	623	244	2	50
2000	1161	796	365	0	80
Total	2993	2103	886	4	188

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During the peak period, an extended zone of southbound congestion was found on I-17 between Union Hills Drive and Camelback Road; average speeds along this segment typically ranged from approximately 25 to 45 mph. Congestion appeared to be caused or exacerbated by weaving and merging associated with the interchanges along this corridor.

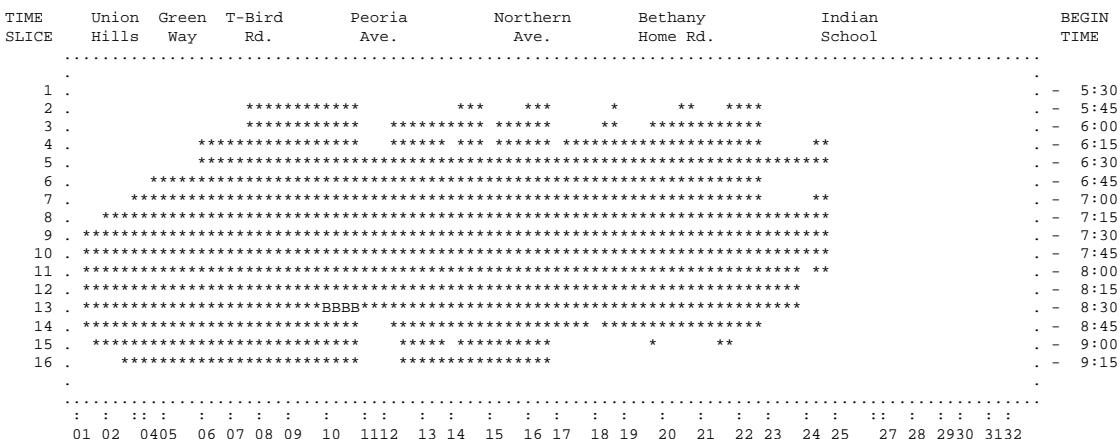
Density Data: Level of Service F (density greater than 45 vehicles per lane-mile) between Bell Road and Greenway Road between 7:30 and 8:30 am; between Greenway Road and Thunderbird Road between 6:30 and 8:30 am; between Thunderbird Road and Cactus Road between 6:30 and 9:00 am; between Cactus Road and Northern Avenue between 6:30 and 8:30 am; between Northern Avenue and Glendale Road between 6:00 and 6:30 am, and again between 7:30 and 8:30; and between Glendale Avenue and Camelback Road between 6:30 and 7:30 am.

FREQ ANALYSIS

Segment C: I-17 SB; Union Hills Drive to Van Buren Street; 5:30 to 9:30 am

Existing Conditions: On this section of I-17, multiple bottlenecks currently exist. Accommodating additional capacity will be costly since a portion of the freeway is depressed, existing right-of-way is limited, and the adjacent properties are well developed.

Queue Diagram of Existing Conditions for Segment C:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

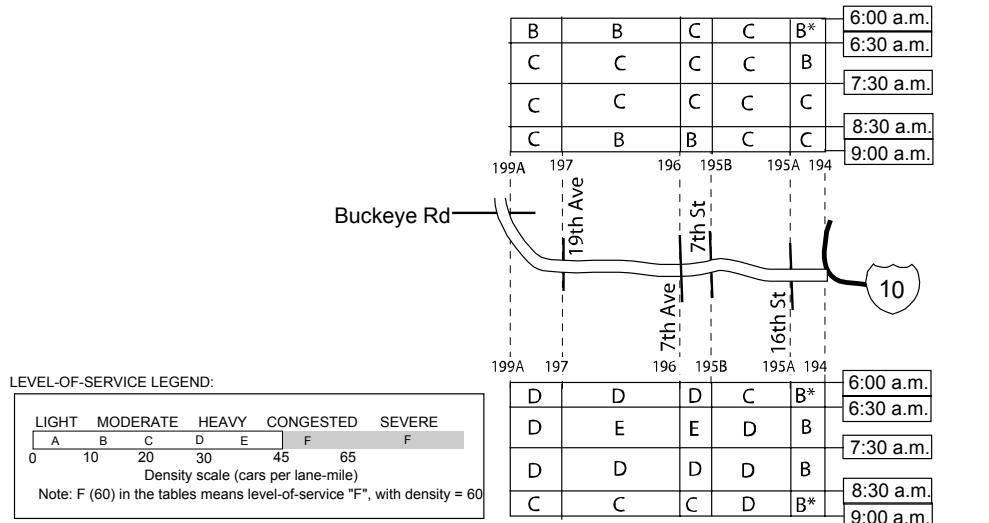
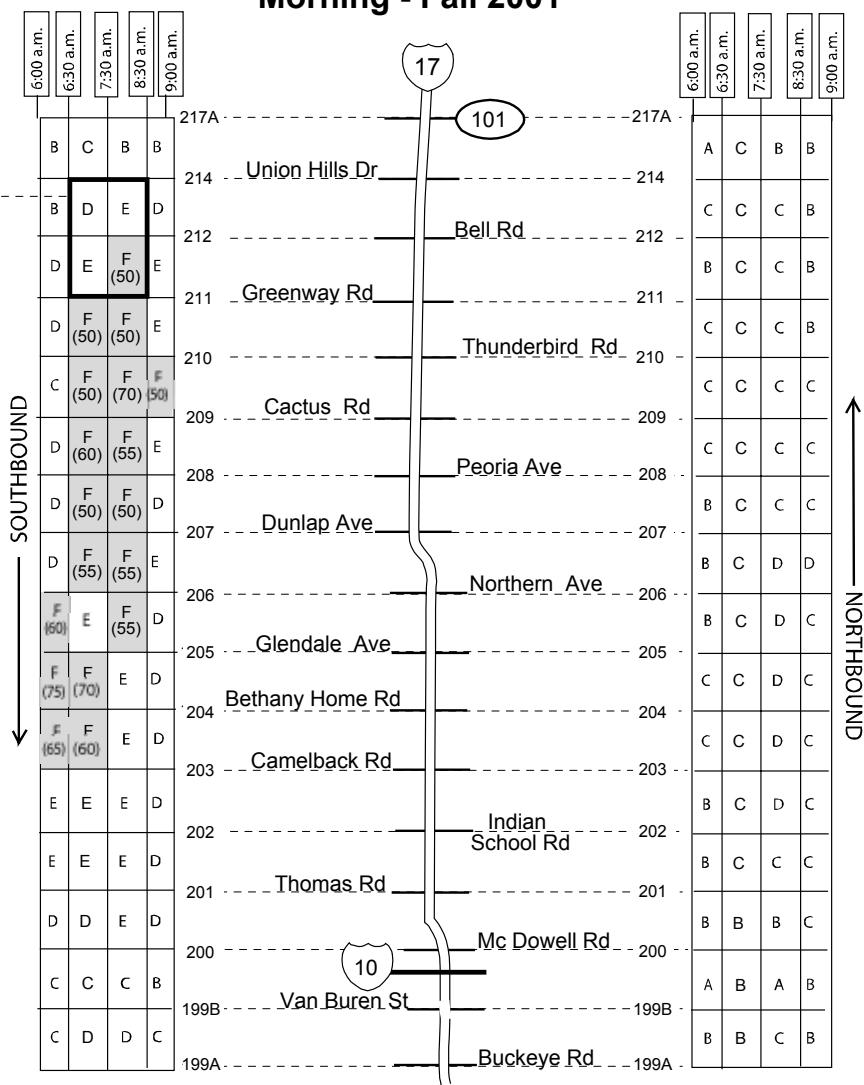
M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

I-17
(Between Loop 101 & I-10)
Morning - Fall 2001

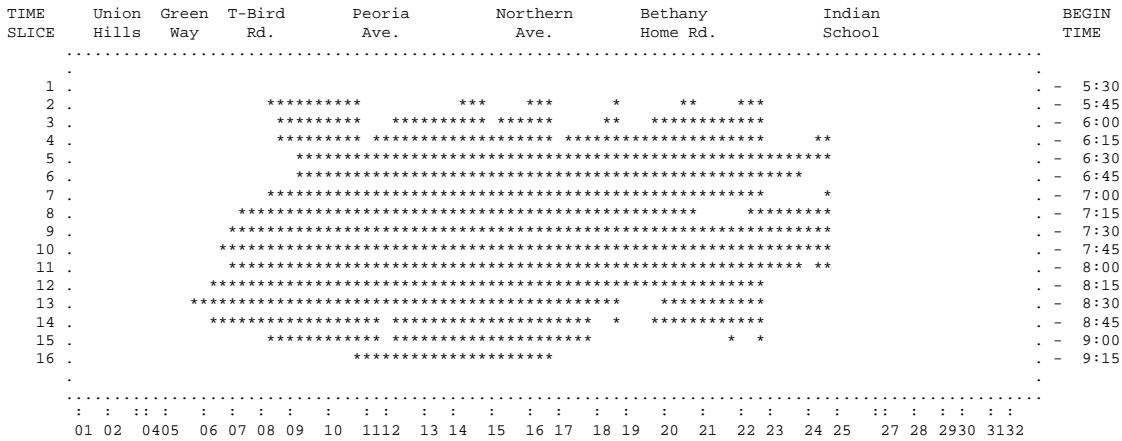
These level-of-service ratings represent the mathematical average of densities, which varied from day-to-day (congested/not congested); when congested, densities typically ranged between 60 and 50 pcplpm with corresponding speed estimates of 35 to 45 mph.



Alternative 1: Add ramp metering at 900 vehicles per hour throughout the segment. This includes changing any existing HOV meter bypass lanes into dual meter ramps. Note that ramp metering is already in place at each on-ramp along this segment.

Result: Mainline congestion is reduced between Union Hills Drive and Thunderbird Road increased queuing at on-ramps will occur. Overall freeway travel time increases slightly.

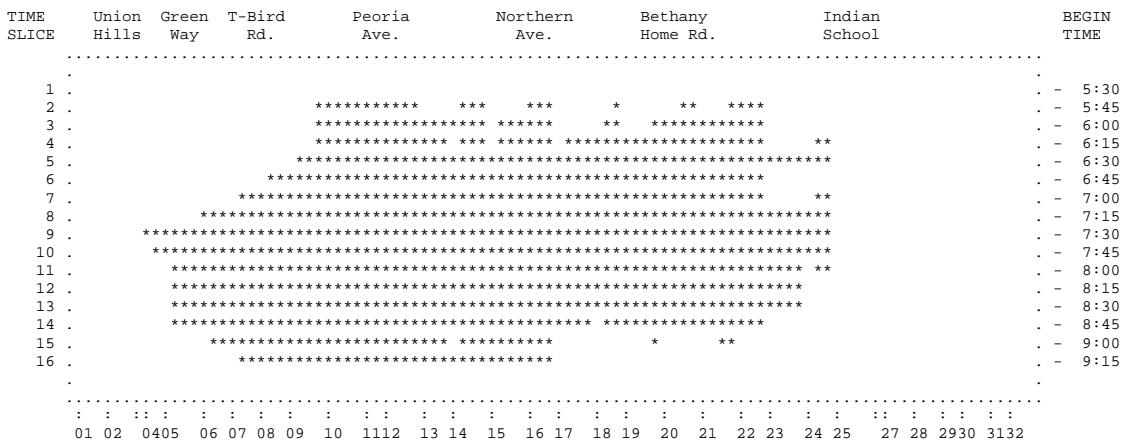
Queue Diagram of Alternative 1 for Segment C:



Alternative 2: Add auxiliary lanes between Union Hills Drive and Peoria Avenue and between McDowell Road and Thomas Road.

Result: Slightly reduces the duration of congestion between Union Hills Drive and Cactus Road. Overall freeway travel time decreases 6%.

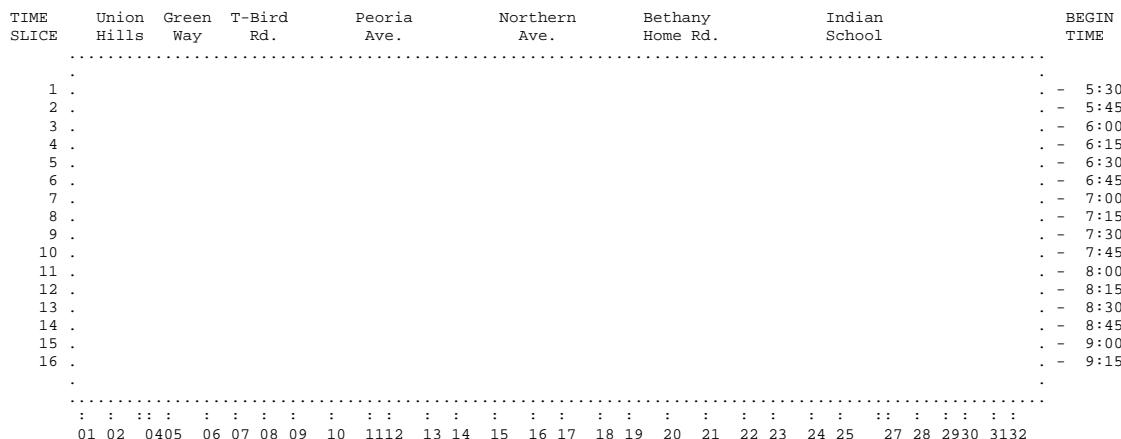
Queue Diagram of Alternative 2 for Segment C:



Alternative 3: Add a general purpose lane from Union Hills Drive to McDowell Road, keeping the existing HOV lane in operation.

Result: This is an extremely expensive alternative, but it will eliminate existing congestion. Overall, freeway travel time decreases 21%.

Queue Diagram of Alternative 3 for Segment C:



ANALYSIS SUMMARY – SEGMENT C

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	14029	9043	23072	27.9
Alternative 1	10861	13110	23971	35.8
Alternative 2	12649	9039	21688	31.2
Alternative 3	6082	12351	18433	67.9

Conclusions/Recommendations:

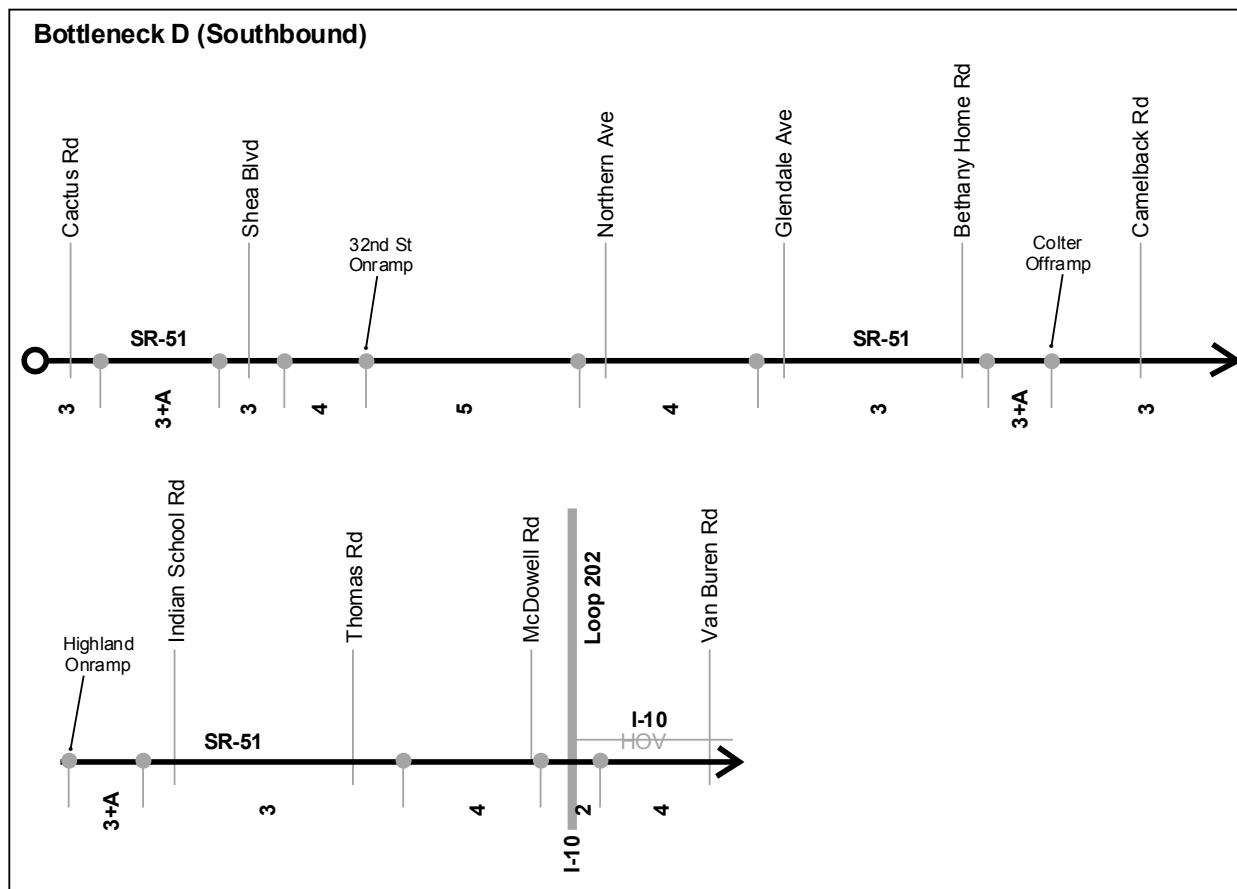
- Short of adding a fourth general purpose lane, the addition of auxiliary lanes north of Union Hills Drive or stricter operation of ramp metering will not significantly reduce existing congestion.
- Additional capacity along this section of the I-17 corridor could be achieved by elevating the existing HOV lanes on a structure. Space for light-rail could also be provided on the structure. The existing HOV lane could then be converted to a general purpose lane. However, eliminating the bottlenecks along I-17 will significantly increase demand downstream at the I-10/I-17 interchange and the downtown section of I-10.

SEGMENT D
SR-51 SOUTHBOUND: CACTUS ROAD TO VAN BUREN STREET (ON I-10)
MORNING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates lane numbers along the D bottleneck segment. Lane numbers are shown below the black line. The letter "A" indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the D bottleneck segment reaches a maximum of 160,000 vehicles (vpd) at the intersection of I-10 and Van Buren St (the southernmost end of the segment). The volume at this location during the AM peak hour is 11,700, which represents 7.3 percent of the total daily volume.

Southbound Traffic Volumes:

The volumes shown in the table below represent southbound counts along the D bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	AM Peak Hour Total Volume	AM Peak Hour GP Volume	AM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
SR- 51 / Shea Blvd	7,200	-----	-----	12.7%	-----
SR- 51 / Via de Ventura	7,600	-----	-----	12.0%	-----
SR- 51 / Highland Av	6,700	-----	-----	10.2%	-----
SR- 51 / Thomas Rd	6,800	-----	-----	7.8%	-----
I-10 / Van Buren St	5,700	5,400	300	7.3%	-----

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	332	1.17	215	39	66	12
1999	350	1.21	243	49	48	10
2000	404	1.39	260	55	67	22
Total	1086	1.26	718	143	181	44

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	332	238	94	0	7
1999	350	252	95	3	5
2000	404	293	109	2	5
Total	1086	783	298	5	17

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During the peak period, southbound congestion was typically found on SR-51 between Northern Avenue and Thomas Road; average speeds typically ranged from approximately 35 to 45 mph. Factors contributing to the congestion were 1) the lane drop [4 lanes to 3] at Glendale Avenue and 2) weaving and merging associated with the interchanges along this corridor. On some days but not others, the tail of the queue extended back to the vicinity of Cactus Road.

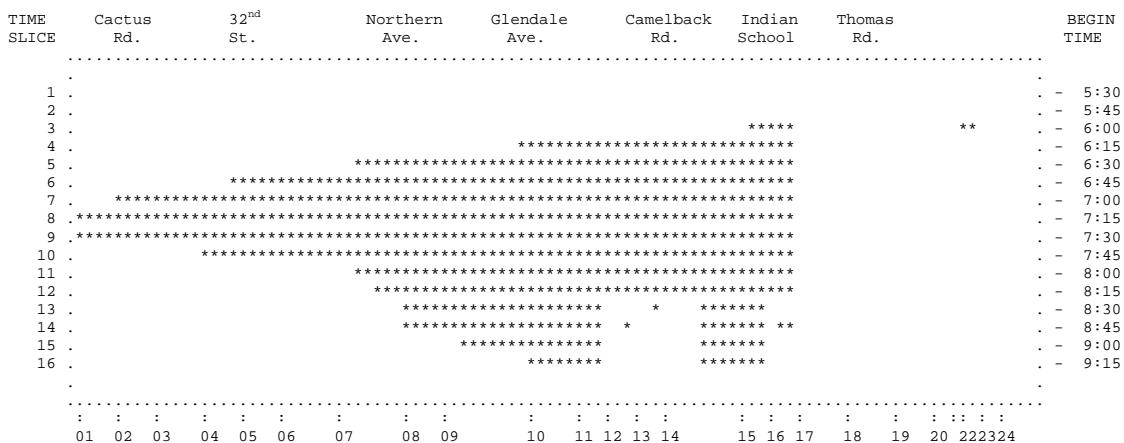
Density Data: (not surveyed before 6:30 am) Level of Service F (density greater than 45 vehicles per lane-mile) between Northern Avenue and Bethany Home Road between 6:30 and 8:30 am, and between Bethany Home Road and Thomas Road between 7:30 and 8:30 am.

FREQ ANALYSIS

Segment D: SR-51 SB; Cactus Road to Van Buren Street; 5:30 to 9:30 am.

Existing Conditions: Bottlenecks currently occur at Bethany Home Road, Indian School Road and between Indian School and Thomas Roads. The resulting congestion extends from Osborn Road to Cactus Road. The bottlenecks, particularly on the south end, are partially a result of the roadway's horizontal and vertical alignments that reduce its free-flow speed and capacity.

Queue Diagram of existing conditions for Segment D:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

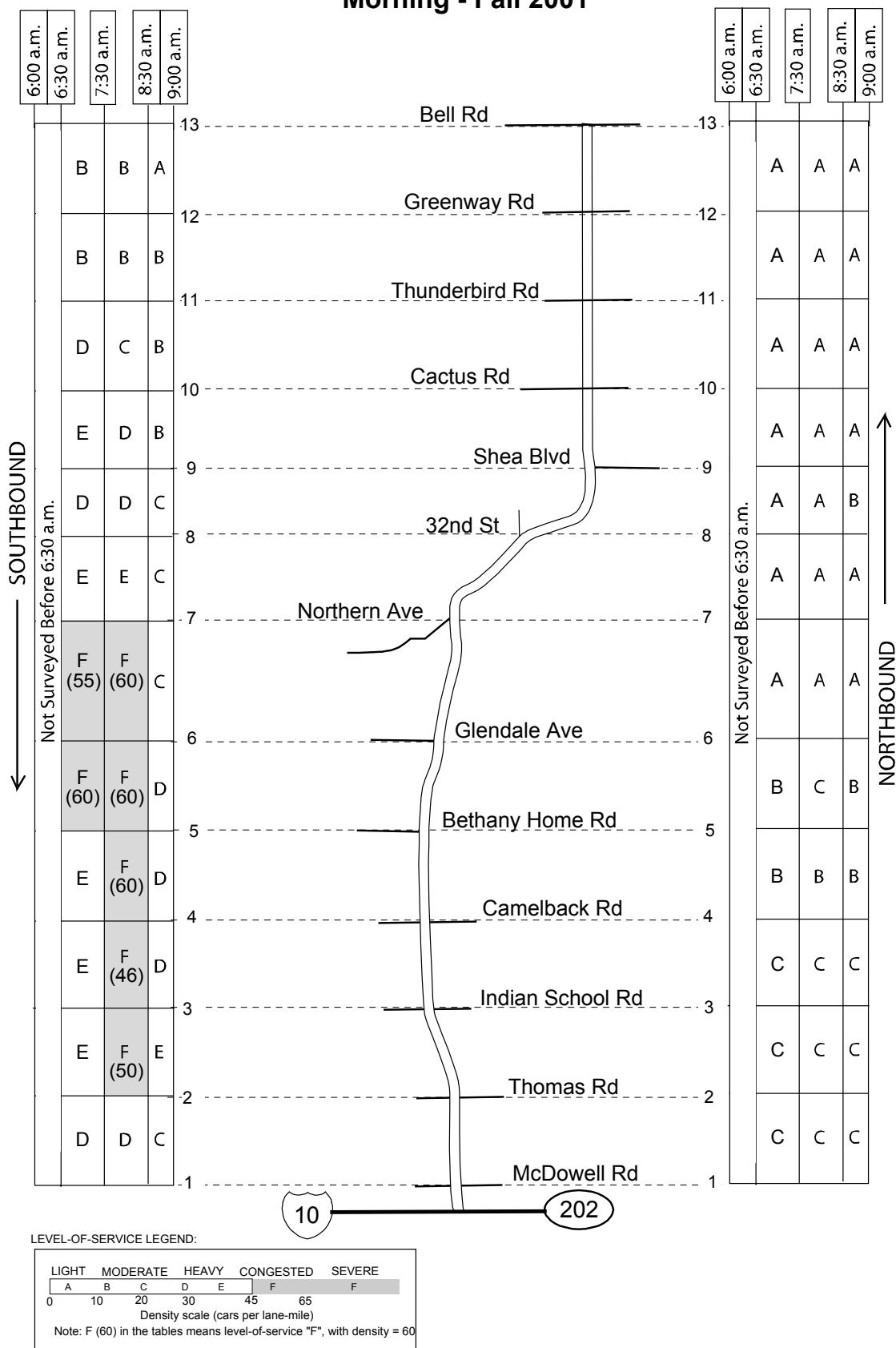
ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

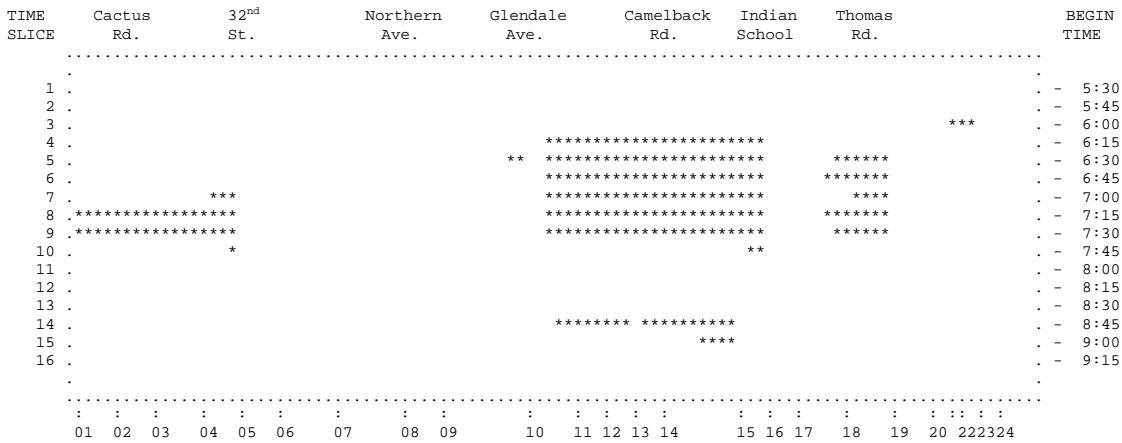
SR 51
Morning - Fall 2001



Alternative 1: Add auxiliary lanes between Glendale Road and Bethany Home Road, and between Indian School Road and Thomas Road.

Result: This alternative reduces congestion at the bottleneck at Bethany Home Road and also benefits the bottleneck at Indian School Road. Previously hidden bottlenecks appear at 32nd Street and Thomas Road. Overall freeway travel time decreases 8%.

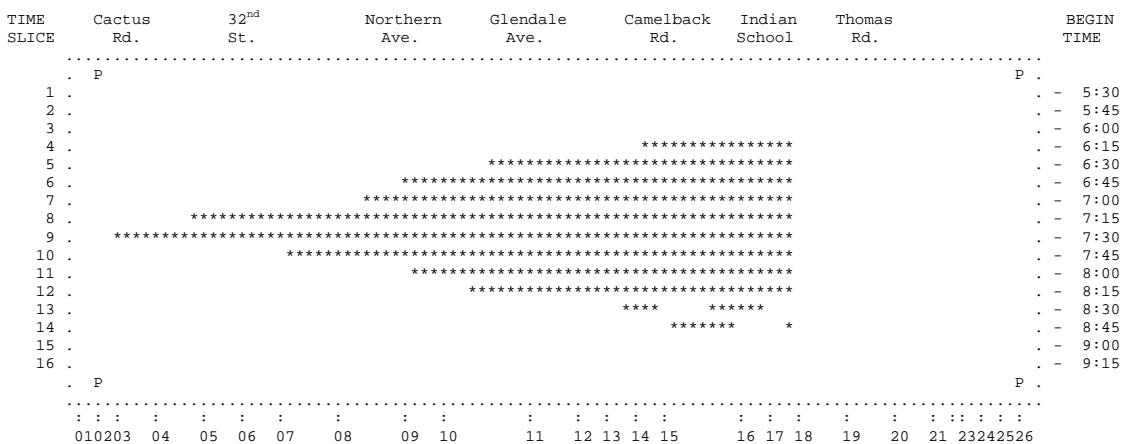
Queue Diagram of Alternative 1 for Segment D:



Alternative 2: Add an HOV lane. For modeling purposes, it was assumed that 10% of the traffic contains 2 or 3+ passengers and thus can use the HOV lane. This alternative does not include the addition of auxiliary lanes.

Result: This alternative decreases the duration of congestion. Overall, freeway travel time decreases 8%.

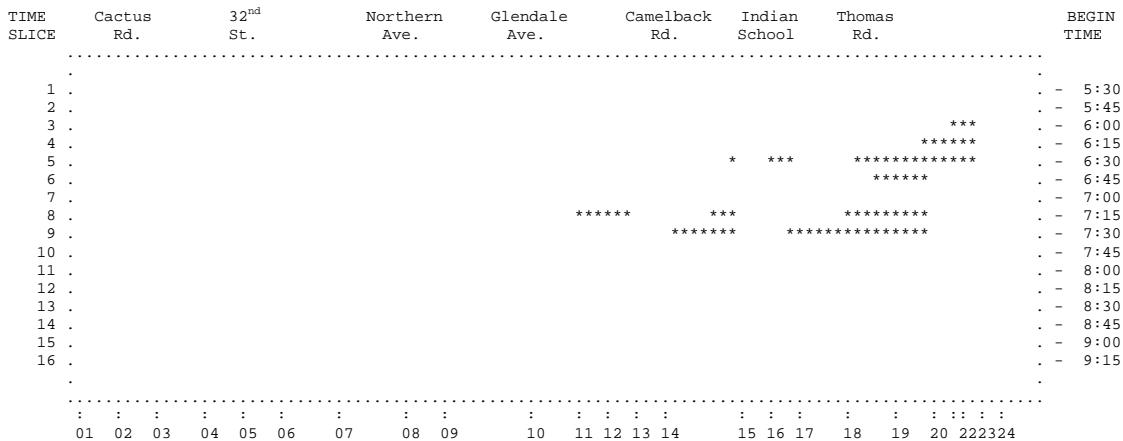
Queue Diagram of Alternative 2 for Segment D:



Alternative 3: Add a general purpose lane for the entire length of the segment. This alternative does not include adding an HOV lane or auxiliary lanes.

Result: Eliminates nearly all congestion except between I-10 and Indian School Road. Overall freeway travel time decreases by 14%.

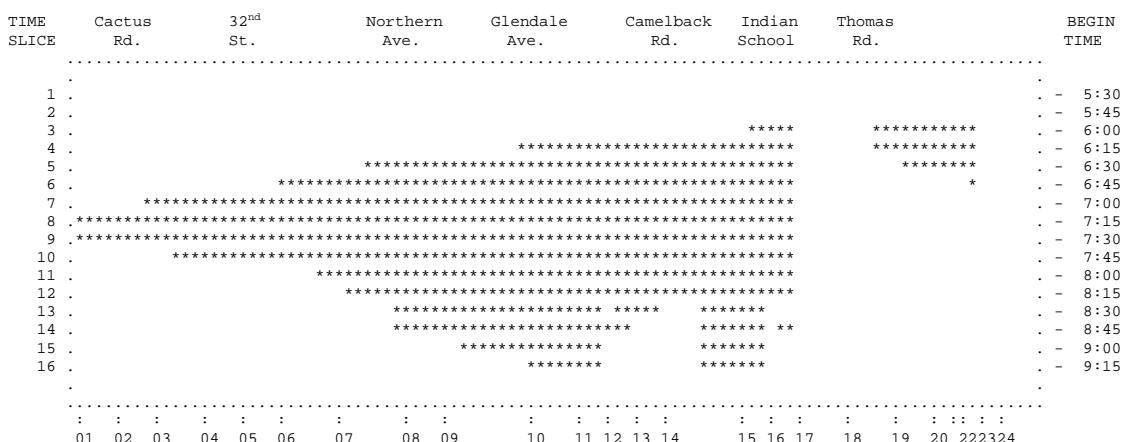
Queue Diagram of Alternative 3 for segment D:



Alternative 4: Add ramp metering at 900 vehicles per hour throughout the segment. This includes changing any existing HOV meter bypass lanes into dual meter ramps. Note that metering of several of these ramps is already in place.

Result: This alternative increases overall freeway travel time by approximately 4% due to increased ramp delay.

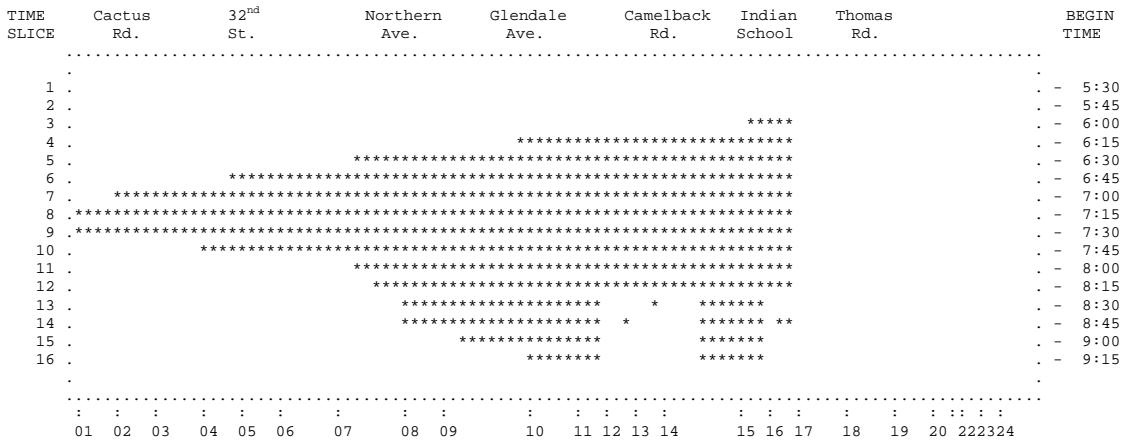
Queue Diagram of Alternative 4 for segment D:



Alternative 5: Add a general purpose lane from the on-ramp from southbound SR-51 to the Washington/Jefferson exit on southbound I-10. The intent of this alternative is to improve access to downtown Phoenix via Washington Street.

Result: This alternative resulted in essentially no impact on congestion on SR-51.

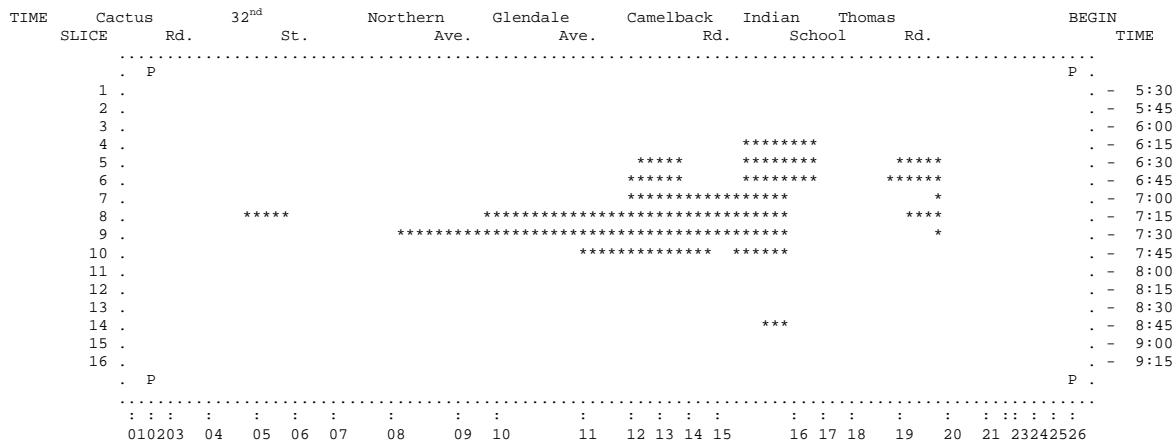
Queue Diagram of Alternative 5 for Segment D:



Alternative 6: Combine Alternative 1 and Alternative 2, adding auxiliary lanes between Glendale Road and Bethany Home Road and between Indian School Road and Thomas Road, and adding an HOV lane.

Result: This alternative significantly reduces congestion. Overall freeway travel time decreases 15%. Although congestion on SR-51 is reduced, it is important to note that this improvement will produce increased demand at the SR-51/SR-202 junction and the SR-51/SR-202/I-10 junction, resulting in a significant increase in congestion on I-10 through the downtown area.

Queue Diagram of Alternative 6 for segment D:



ANALYSIS SUMMARY – SEGMENT D

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	8708	26468	35176	36.2
Alternative 1	5810	26680	32490	56.2
Alternative 2	5631	24908	30539	43.1
Alternative 3	5308	27908	33215	63.0
Alternative 4	8744	27998	36743	35.8
Alternative 5	8691	26468	35159	36.2
Alternative 6	4363	25324	29686	56.0

Conclusions/Recommendations:

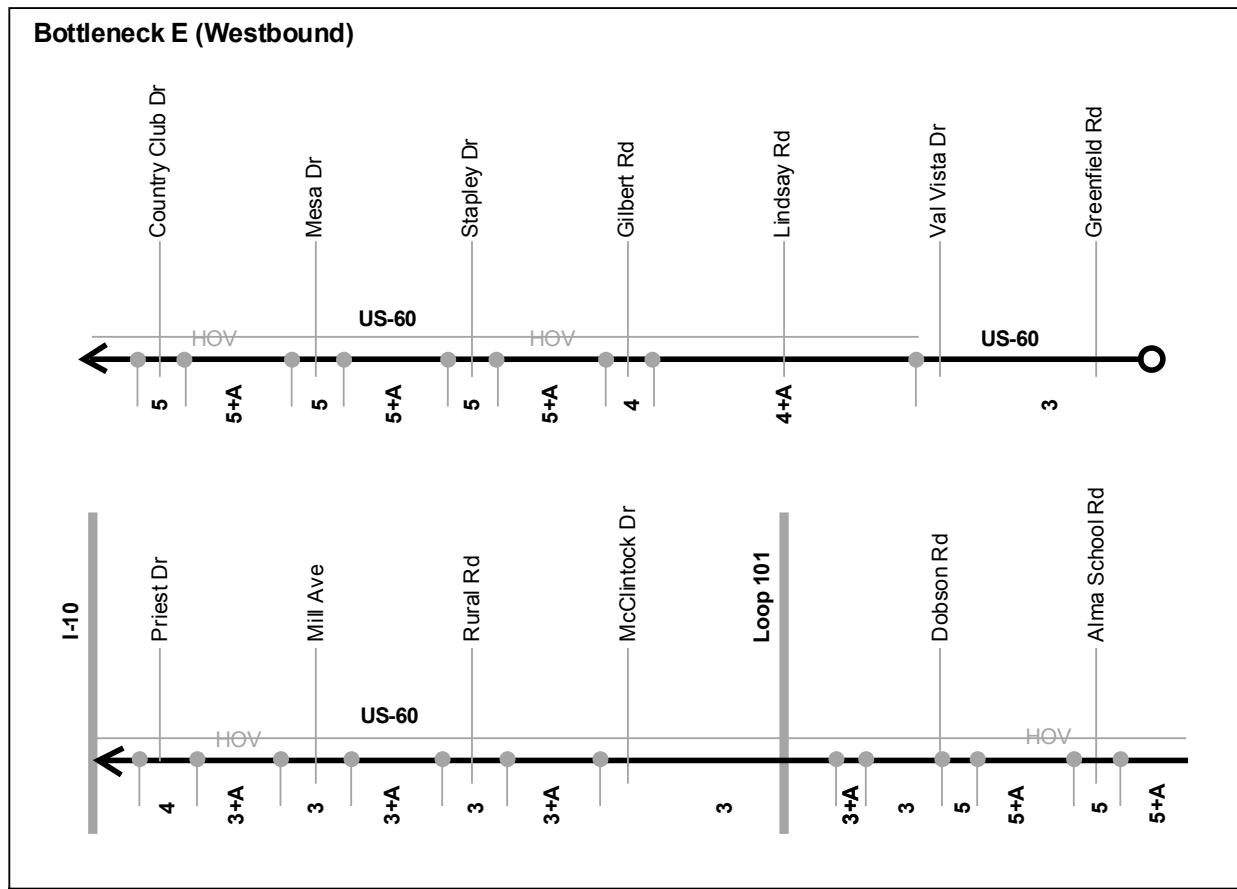
1. The addition of the currently planned HOV lane in combination with adding auxiliary lanes between Glendale Avenue and Bethany Home Road and between Indian School Road and Thomas Road will significantly reduce existing congestion on southbound SR-51 during the morning peak traffic period.
2. The addition of a lane on the southbound to westbound ramp connecting SR-51 with I-10 will produce greater demand and congestion on the downtown section of I-10. Therefore, this improvement is not recommended.

SEGMENT E
US-60 WESTBOUND: GREENFIELD ROAD TO I-10
MORNING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the E bottleneck segment. Lane numbers are shown below the black line. The letter "A" indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the E bottleneck segment reaches a maximum of 176,000 vehicles (vpd) at the intersection of US-60 and Center Street (between Country Club Drive and Mesa Drive). The volume at this location during the AM peak hour is 11,400, which represents 6.5 percent of the total daily volume.

Westbound Traffic Volumes:

The volumes shown in the table below represent westbound counts along the E bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	AM Peak Hour Total Volume	AM Peak Hour GP Volume	AM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
I-10 / Greenfield Rd	4,500	-----	-----	6.5%	-----
I-17 / Gilbert Rd	5,000	-----	-----	6.3%	-----
I-17 / Mesa Dr	6,500	-----	-----	7.2%	1.5%
I-17 / Priest Dr	6,600	-----	-----	7.9%	0.9%

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	593	1.75	439	64	69	21
1999	594	1.72	427	59	74	34
2000	738	2.09	551	73	86	28
Total	1925	1.85	1417	196	229	83

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	593	436	157	0	29
1999	594	396	197	1	28
2000	738	526	210	2	24
Total	1925	1358	564	3	81

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During the peak period, westbound congestion was found on US-60 between Greenfield Road and Country Club Drive. Ongoing construction between Val Vista Drive and Dobson Road may have exacerbated the congestion (right shoulder closed). Average speeds along this segment typically ranged from approximately 20 to 30 mph. Traffic flow consistently improved west of Country Club Drive, where the road widened from 3 to 4 lanes.

During most observations, westbound congestion was found on US-60 between Loop 101 and Mill Avenue; average estimated speeds along this segment typically ranged from approximately 15 to 25 mph. Ongoing construction between McClintock Drive and Mill Avenue may have exacerbated the congestion (right shoulder closed).

During the Peak period, westbound congestion was found on US-60 approaching I-10; average estimated speeds ranged widely, from approximately 25 to 45 mph. The merge into congested flow on I-10 appeared to cause or exacerbate the congestion.

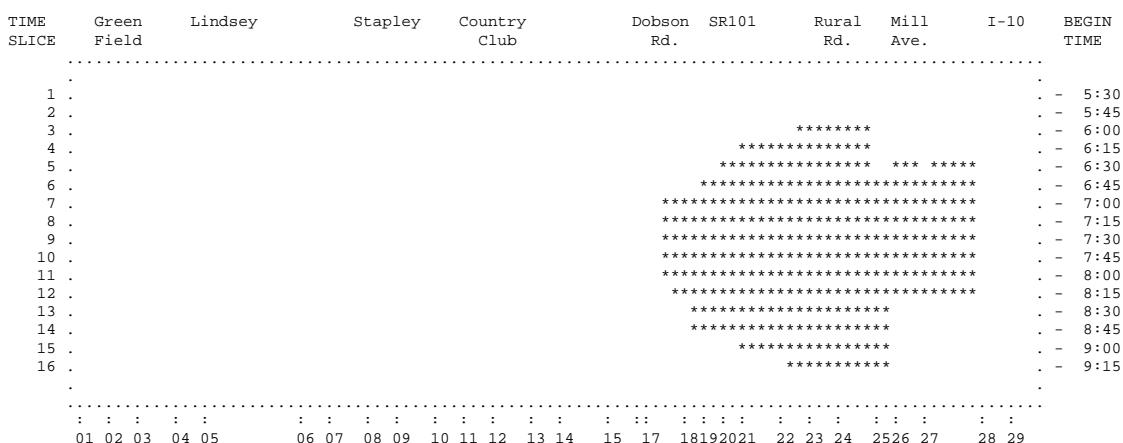
Density Data: Level of Service F (density greater than 45 vehicles per lane-mile) between I-10 and Priest Drive between 6:30 and 8:30 am; between Mill Avenue and McClintock Drive between 6:00 and 8:30 am; between Country Club Drive and Val Vista Drive between 6:00 and 9:00 am; and between Val Vista Drive and Greenfield Road between 6:00 and 7:30 am.

FREQ ANALYSIS

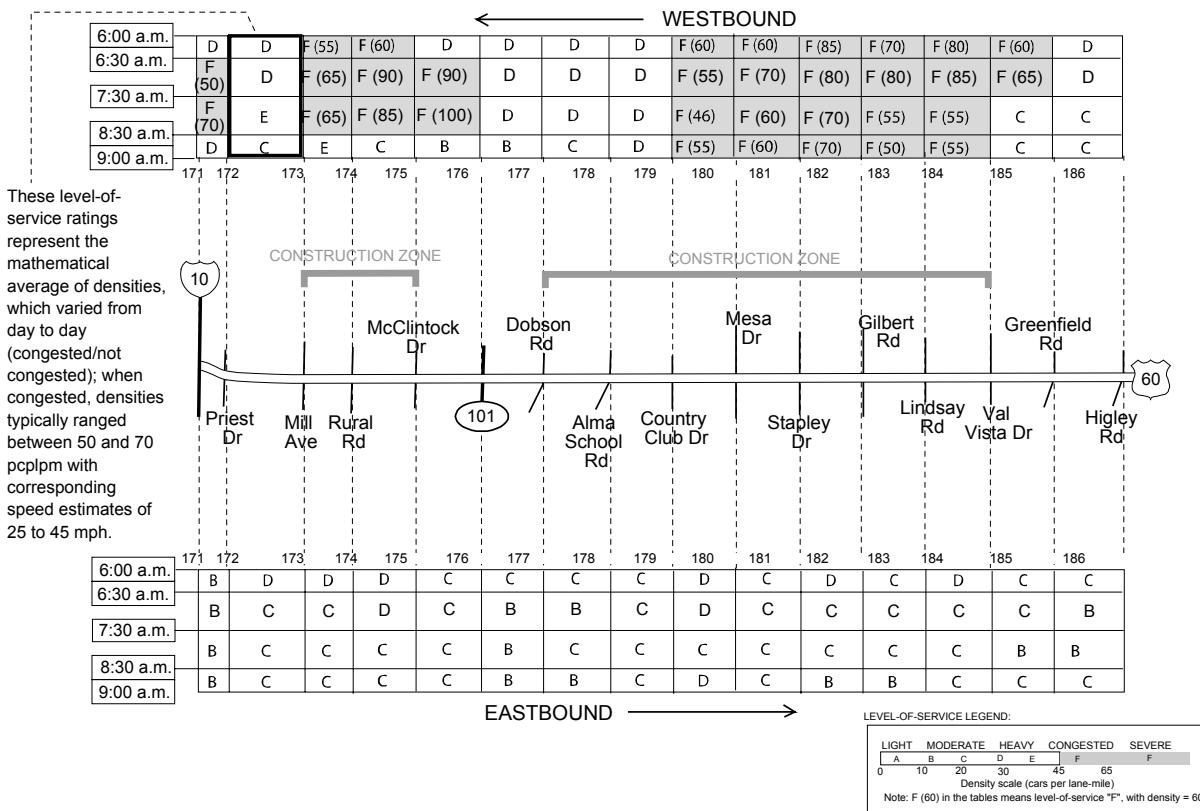
Segment E: US-60 WB; Greenfield Road to I-10; 5:30 to 9:30 am

Existing Conditions: Bottlenecks currently occur at Loop 101, between Rural Road and Mill Avenue and at Priest Road. Since traffic data for this freeway segment was collected during construction, it was not possible to develop an accurate model of existing conditions. The existing conditions model developed for this segment includes the new freeway geometry and lane configuration that is under construction. This includes a cross-section of 3+1 within the City of Tempe and 5+1+A from the Loop 101 interchange to Power Road.

Queue Diagram of Existing Conditions for Segment E
(Results reflect possible conditions after the completion of construction):



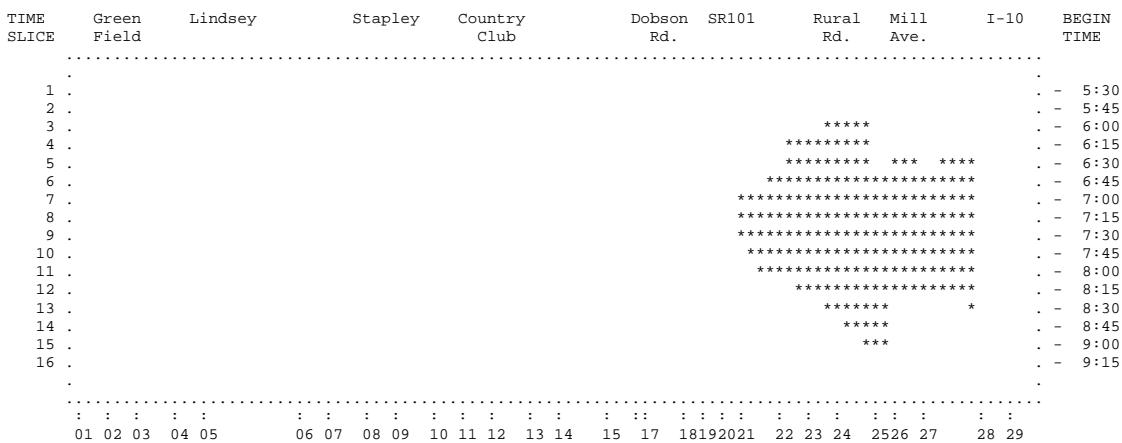
US Route 60
(Between I-10 & Higley Rd)
Morning - Fall 2001



Alternative 1: Add ramp metering at 900 vehicles per hour throughout the segment.

Result: Congestion on the freeway segment within the City of Tempe is reduced; however, lengthy queues at on-ramps will occur. Overall freeway travel time increases 29%.

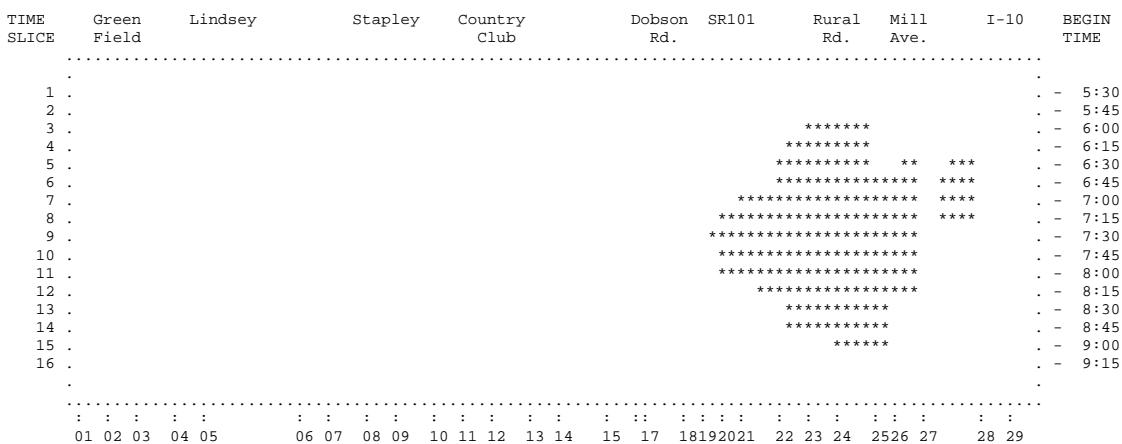
Queue Diagram of Alternative 1 for Segment E:



Alternative 2: Include the HOV left exit-ramp to the I-10 HOV lane. For modeling purposes it was assumed that 10% of the traffic contains 2 or 3+ passengers and thus can use the HOV ramp. This ramp is already in operation.

Result: This alternative reduces delays somewhat. Overall freeway travel time decreases 5%.

Queue Diagram of Alternative 2 for Segment E:



Alternative 3: The intersection improvements needed to eliminate the existing bottlenecks were evaluated. Providing four general-purpose lanes from Loop 101 to Mill Avenue, five lanes from Mill Avenue to I-10, and two lanes on the WB to SB freeway-to-freeway connector ramp will eliminate peak period congestion that occurs between Loop 101 and I-10.

Result: Eliminating the existing bottlenecks between Loop 101 and I-10 could significantly reduce overall freeway travel time on this section of US-60. The actual travel time savings will depend upon the latent demand that returns to US-60 once on-going construction is completed. Conditions downstream on I-10 will be impacted by the higher traffic volumes entering from the US-60 westbound on-ramp. The potential impacts of this increased demand at the westbound I-10/US-60 ramp junction were evaluated and are presented in the discussion addressing potential improvements to I-10 from Ray Road to 40th Street (Segment B).

Queue Diagram of Alternative 3 for Segment E:

TIME SLICE	Green Field	Lindsey	Stapley	Country Club	Dobson Rd.	SR101	Rural Rd.	Mill Ave.	I-10	BEGIN TIME
1 .									.	5:30
2 .									.	5:45
3 .									.	6:00
4 .									.	6:15
5 .									.	6:30
6 .									.	6:45
7 .									.	7:00
8 .									.	7:15
9 .									.	7:30
10 .									.	7:45
11 .									.	8:00
12 .									.	8:15
13 .									.	8:30
14 .									.	8:45
15 .									.	9:00
16 .									.	9:15
.									.	
:	:	:	:	:	:	:	:	:	:	:
01	02	03	04	07	09	10	11	12	13	14
									1718	19
										20
										21
										22

Analysis Summary – Segment E

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	8899	4504	13403	40.9
Alternative 1	6813	10583	17396	51.1
Alternative 2	7553	5259	12812	47.1
Alternative 3	5275	5259	10534	67.5

Conclusions/Recommendations:

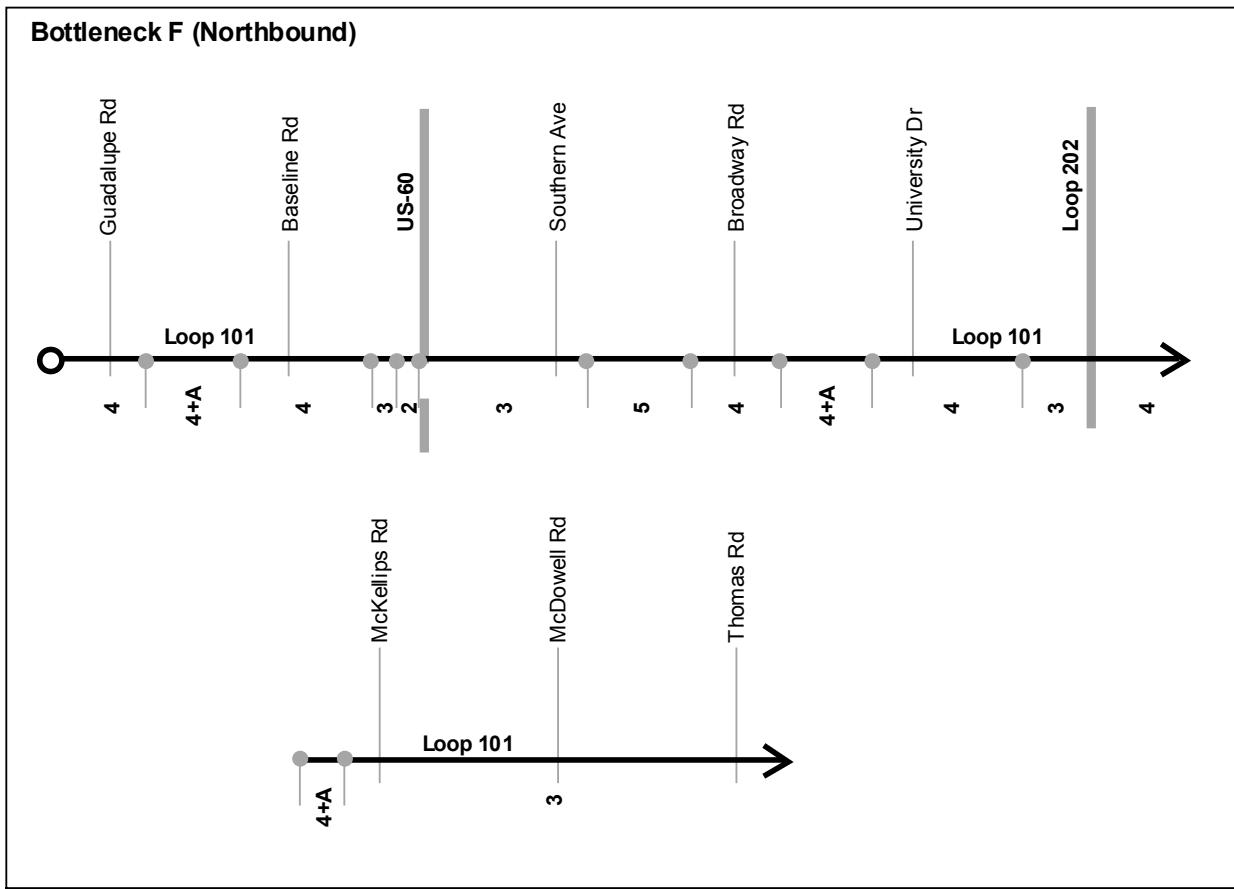
Although an accurate model of existing conditions on this freeway section could not be developed, the evaluation of conditions with the on-going construction project complete indicates that the reduced freeway capacity (3+1+A) west of Loop 101 will create congestion. Construction of a collector-distributor road on I-10 will increase the capacity of the I-10/US-60 junction, potentially reducing the level of congestion on westbound US-60 during the morning peak period. Eliminating the bottleneck west of Loop 101 will result in higher traffic volumes entering I-10 from the westbound US-60 on-ramp, thereby impacting I-10 traffic flow.

SEGMENT F
LOOP 101 NORTHBOUND: GUADALUPE ROAD TO THOMAS ROAD
MORNING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the F bottleneck segment. Lane numbers are shown below the black line. The letter "A" indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the F bottleneck segment reaches a maximum of 192,000 vehicles (vpd) north of the intersection of Loop 101 and Southern Ave. The volume at this location during the AM peak hour is 14,200, which represents 7.4 percent of the total daily volume.

Northbound Traffic Volumes:

The volumes shown in the table below represent northbound counts along the F bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

Location	AM Peak Hour Total Volume	AM Peak Hour GP Volume	AM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
Loop 101 / Southern Av	8,500	-----	-----	8.7%	-----
Loop 101 / University Dr	9,100	-----	-----	9.4%	-----
Loop 101 / McKellips Rd	6,600	-----	-----	8.1%	1.2%
Loop 101 / McDowell Rd	6,500	-----	-----	8.4%	-----
Loop 101 / Thomas Rd	7,000	-----	-----	8.2%	0.5%

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	97	0.68	63	16	14	4
1999	72	0.40	43	7	14	8
2000	143	0.64	94	12	28	9
Total	312	0.58	200	35	56	21

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	97	71	26	0	2
1999	72	57	14	1	7
2000	143	105	37	1	0
Total	312	233	77	2	9

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During the peak period, an extended zone of northbound congestion was found on Loop 101 between Guadalupe Road and Loop 202; average estimated speeds through this segment typically ranged from 30 to 50 mph. Factors contributing to the congestion were 1) the lane drop [3 lanes to 2] at US-60, and 2) vehicles weaving into the right two lanes to exit at Loop 202.

During most observations, northbound congestion was found on Loop 101 between Loop 202 and Thomas Road; average estimated speeds through this segment typically ranged from 30 to 50 mph. The primary bottleneck was the lane drop [4 lanes to 3] at McKellips Road; north of McKellips Road, vehicle speeds typically improved.

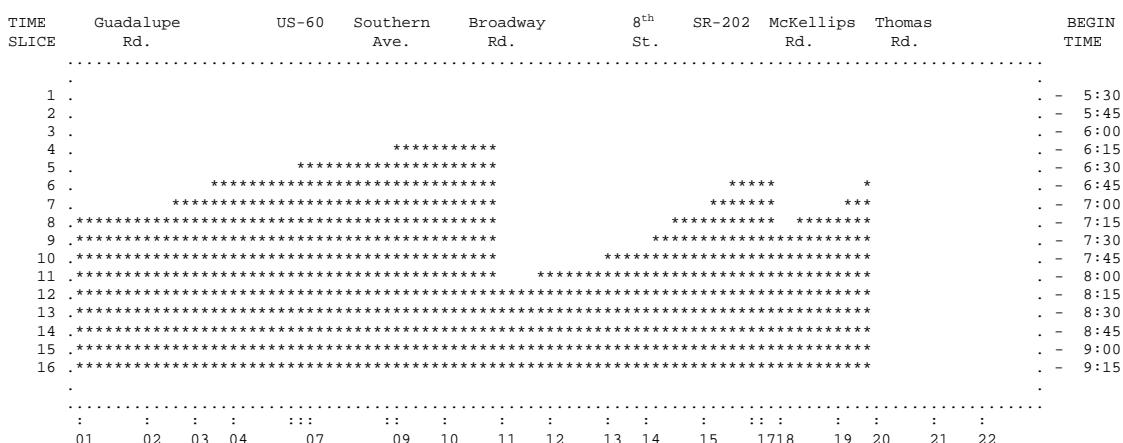
Density Data: Level of Service F (density greater than 45 vehicles per lane-mile) southbound between Thomas Road and McDowell Road between 7:30 and 8:30 am; northbound between Thomas Road and McDowell Road between 6:30 and 9:00 am; between McDowell Road and the Loop 202 exits between 7:30 and 8:30 am; between University Drive and Apache Boulevard between 6:30 and 7:30 am; between Apache Boulevard and Southern Avenue between 6:30 and 8:30 am; and between the US-60 interchange and Baseline Road between 6:30 and 7:30 am.

FREQ ANALYSIS

Segment F: *Loop 101 NB; Guadalupe Road to Thomas Road; 5:30 to 9:30 AM*

Existing Conditions: Existing bottlenecks occur at Thomas Road, McKellips Road and Broadway Road. The resulting congestion extends from Thomas Road to south of Guadalupe Road. The two freeway interchanges spaced 3.5 miles apart and six on-ramps within these 3.5 miles create significant merging and weaving activity that contributes to the reduced freeway capacity and congestion.

Queue Diagram of existing conditions for Segment F:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

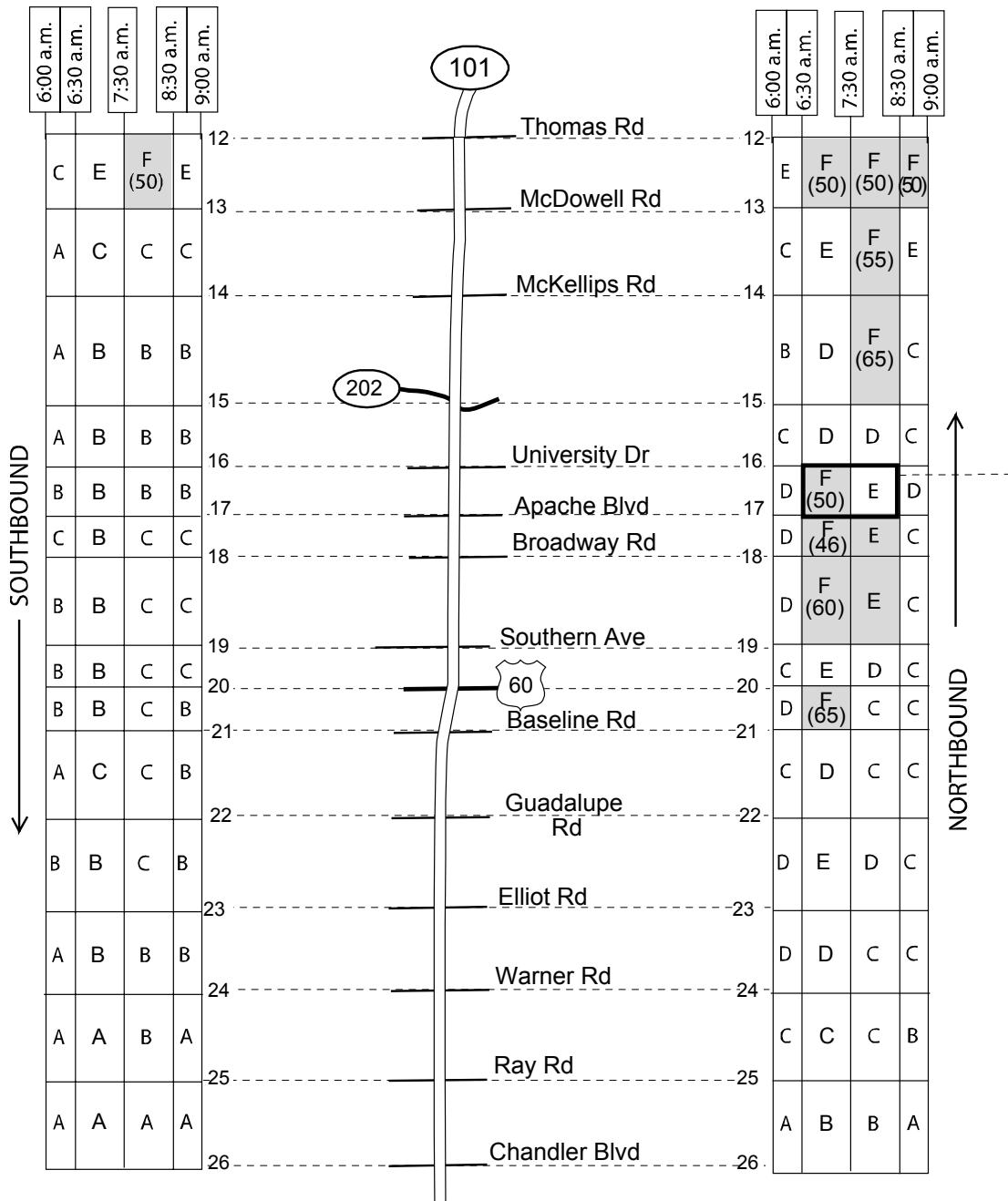
ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

Loop 101-Pima Freeway
(Between Thomas Rd & Chandler Blvd)
Morning - Fall 2001



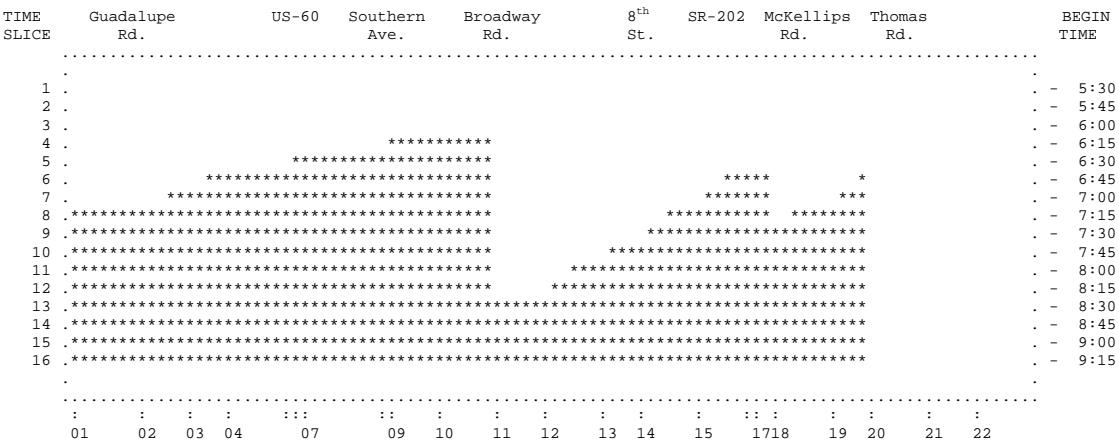
101

These level-of-service ratings represent the mathematical average of densities, which varied from day-to-day (congested/not congested); when congested, densities typically ranged between 60 and 45 pcplpm with corresponding speed estimates of 30 to 50 mph.

Alternative 1: Add a general-purpose lane through the Loop 101/Loop 202 interchange.

Result: This alternative does nothing to relieve congestion. Overall, freeway travel time increases slightly.

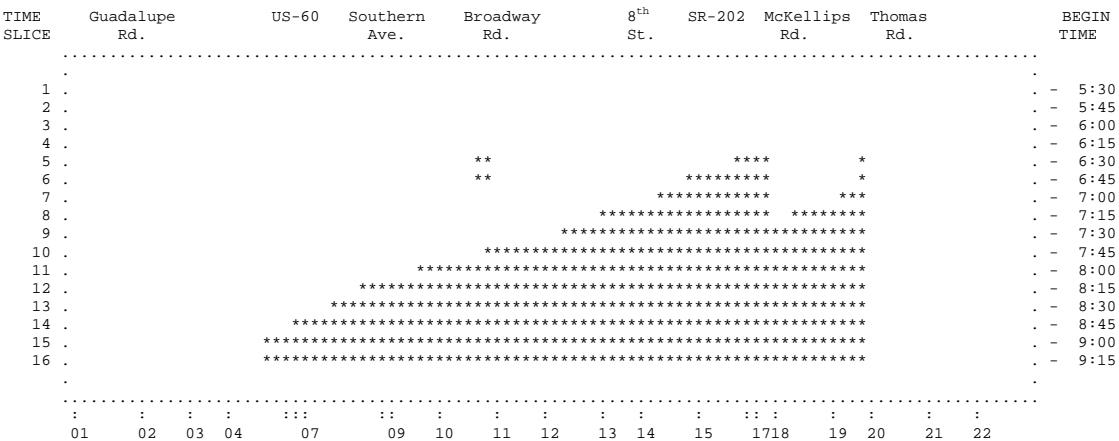
Queue Diagram of Alternative 1 for Segment F:



Alternative 2: Add a general purpose lane from the US-60 interchange through the Loop 202 interchange.

Result: This alternative significantly reduced congestion at the Broadway Road bottleneck, however, the bottlenecks at McKellips Road and Thomas Road continue to create congestion. Overall, freeway travel time increases slightly.

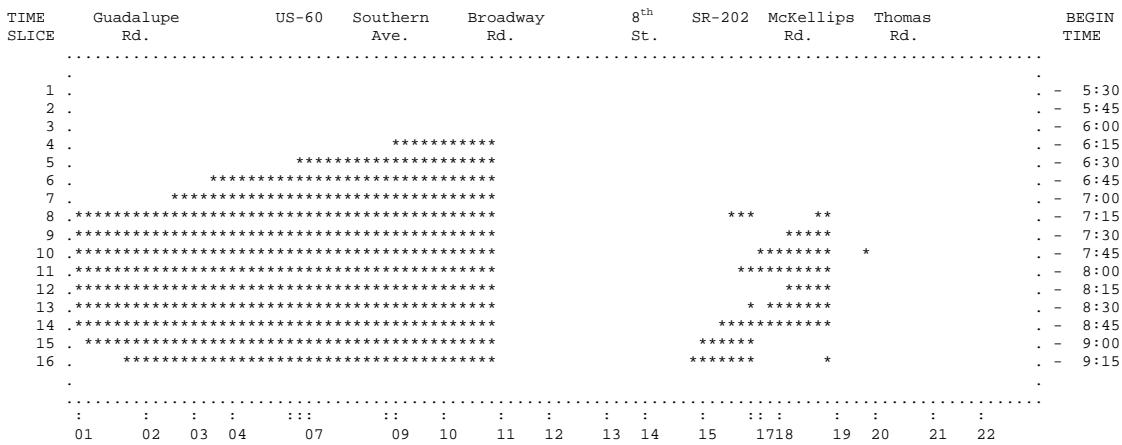
Queue Diagram of Alternative 2 for Segment F:



Alternative 3: Add auxiliary lanes from the McKellips Road to Thomas Road. This alternative does not include the addition of a general purpose lane.

Result: This alternative reduces congestion at the Thomas Road and McKellips Road bottlenecks, however does not impact the Broadway Road bottleneck. Overall, freeway travel time decreases 10%.

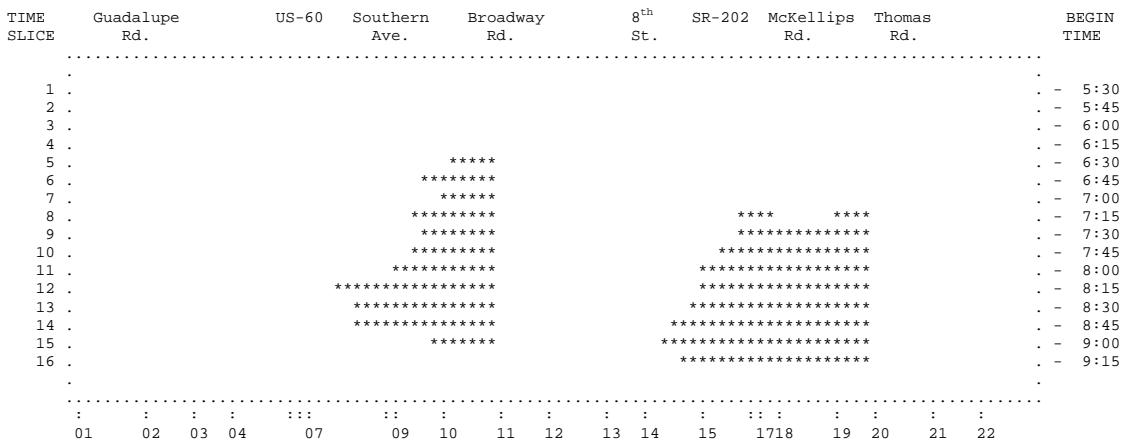
Queue Diagram of Alternative 3 for Segment F:



Alternative 4: Add ramp metering at 900 vehicles per hour and 1600 for dual meters throughout the segment.

Result: This alternative reduces congestion at each bottleneck, although long queues will occur at several on-ramps. Overall, freeway travel time decreases 5%.

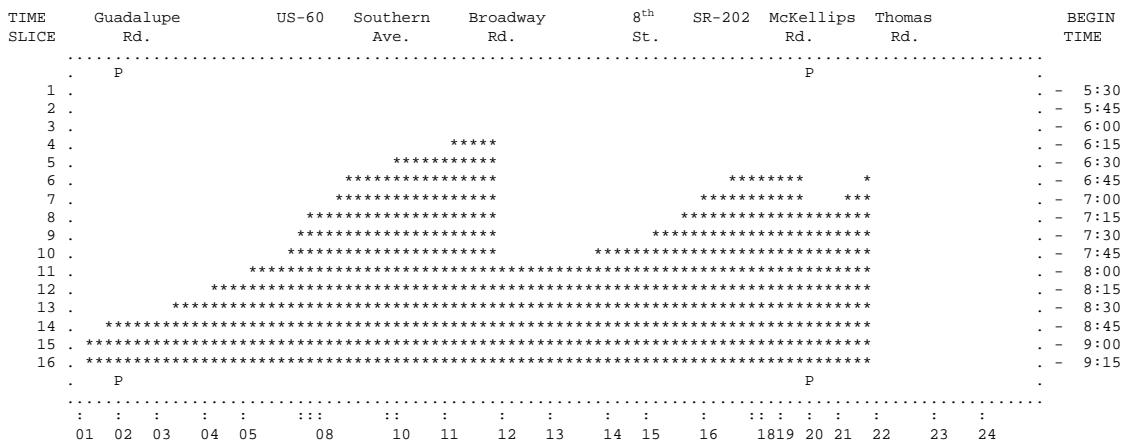
Queue Diagram of Alternative 4 for Segment F:



Alternative 5: Add an HOV lane to this segment. For modeling purposes, it was assumed that 10% of the traffic contains 2 or 3+ passengers and thus can use the HOV lane. This does not include the addition of any other physical improvements.

Result: This alternative decreases the duration of the congestion. Overall, freeway travel time decreases 15%.

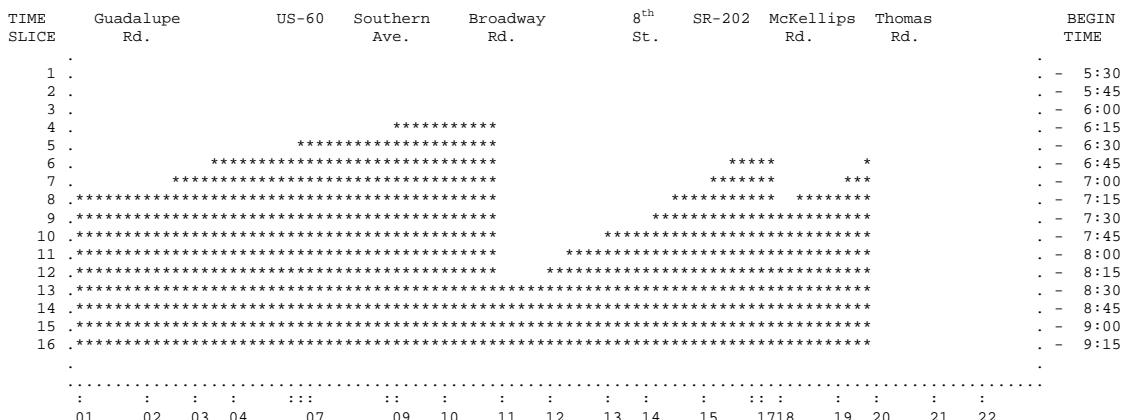
Queue Diagram of Alternative 5 for Segment F:



Alternative 6: Extend the auxiliary lane from the Broadway Road on-ramp to the Loop 202 off-ramp. The two outside lanes are exit only to Loop 202. The intent of this improvement is to provide added capacity for the heavy north to west movement at the Loop 101/Loop 202 interchange. Currently, peak hour demand at the northbound Loop 202 off-ramp exceeds 5600 vph. The two-lane exit ramp provides a capacity of between 3000 and 3600 vph.

Result: This alternative does not provide any benefit to traffic flow on northbound Loop 101 or to the Loop 101 to Loop 202 connector ramp. However, it will provide additional storage for queuing on the connector ramp. Additional ramp capacity is needed in order to alleviate the congestion on the connector ramp.

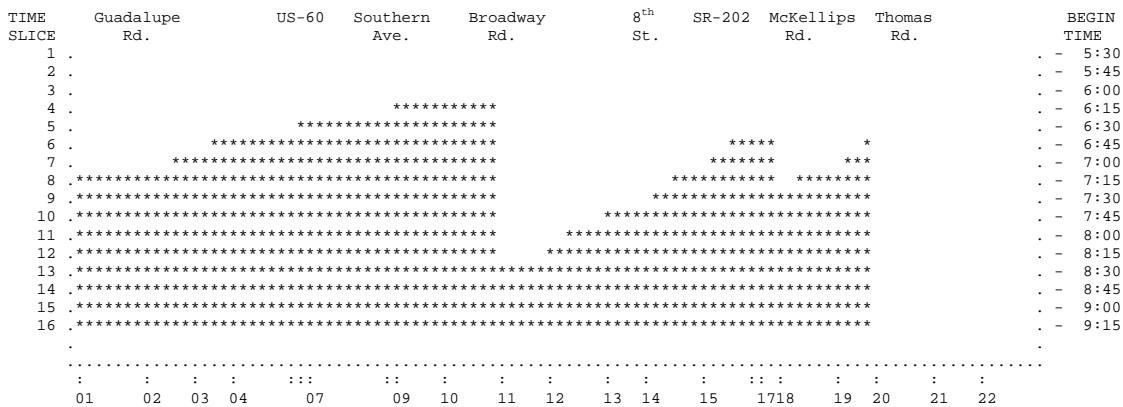
Queue Diagram of Alternative 6 for Segment F:



Alternative 6A: Add a third lane to the northbound Loop 202 off-ramp.

Result: This added ramp capacity significantly reduces ramp delay, particularly on the Loop 101 to Loop 202 connector ramp; it does not however, reduce congestion on northbound Loop 101. The impacts of this alternative on traffic flow on Loop 202 are addressed in the discussion for Segment G.

Queue Diagram of Alternative 6A for Segment F:



ANALYSIS SUMMARY – SEGMENT F

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	13937	20356	34293	16.9
Alternative 1	14067	20256	34323	16.9
Alternative 2	10607	24384	34991	24.0
Alternative 3	10652	20239	30891	23.6
Alternative 4	5855	35858	41712	41.3
Alternative 5	9762	19443	29205	19.8
Alternative 6	14093	20349	34442	16.7
Alternative 6A	14093	5756	19850	16.7

Conclusions/Recommendations:

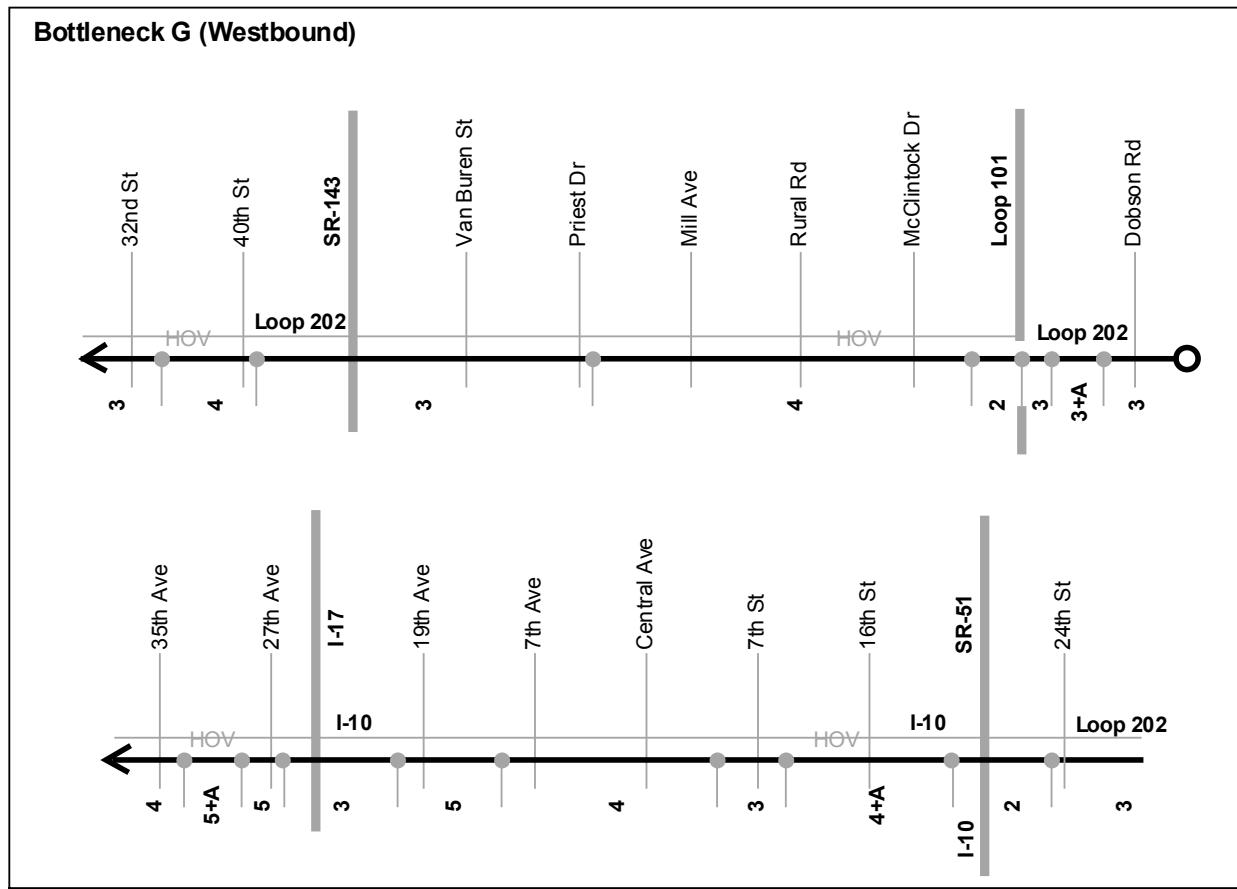
1. The construction of auxiliary lanes from McKellips Road to Thomas Road, in combination with the installation of ramp metering, will reduce existing congestion on this section of Loop 101 to some degree. Adding a fourth general purpose lane north of McKellips Road will reduce congestion further, however, the bottleneck at Broadway Road will remain.
2. Installation of ramp metering will benefit traffic flow, particularly between the US-60 and Loop 202 interchanges.
3. Heavy demand at the northbound Loop 101 to Loop 202 connector ramp exceeds ramp capacity by approximately 50%. This demand may decrease upon completion of the widening on US-60. Adding ramp capacity will increase the volume of traffic entering westbound Loop 202 from Loop 101, thereby producing added congestion on Loop 202.

SEGMENT G
LOOP 202 WESTBOUND: DOBSON ROAD TO 35TH AVENUE (ON I-10)
MORNING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the G bottleneck segment. Lane numbers are shown below the black line. The letter "A" indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the G bottleneck segment reaches a maximum of 259,000 vehicles (vpd) at the intersection of I-10 and 7th St. The volume at this location during the AM peak hour is 17,900, which represents 6.9 percent of the total daily volume.

Westbound Traffic Volumes:

The volumes shown in the table below represent westbound counts along the G bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	AM Peak Hour Total Volume	AM Peak Hour GP Volume	AM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
Loop 202 / Dobson Rd	5,400	-----	-----	13.1	-----
Loop 202 / Mill Av	9,800	8,700	1,100	9.2%	1.0%
Loop 202 / 32 nd St	8,300	7,400	900	7.5%	0.8%
I-10 / 16 th St	9,900	8,700	1,200	7.2%	1.5%
I-10 / 7 th Av	8,800	8,400	400	7.9%	-----
I-10 / 31 st Av	5,900	5,500	400	5.3%	6.6%

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	1369	2.30	1036	145	149	39
1999	1229	1.97	903	135	142	49
2000	1292	1.98	937	178	145	32
Total	3890	20.8	2876	458	436	102

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	1369	1019	347	3	28
1999	1229	893	333	3	43
2000	1292	913	376	3	41
Total	3890	2825	1056	9	122

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on pages G-4 and G-5.

Observations: During most observations, westbound congestion was typically found on Loop 202 between Loop 101 (Pima Freeway) and Mill Avenue; average estimated speeds typically ranged from approximately 30 to 50 mph. This congestion appeared to be caused or exacerbated by weaving and merging associated with the interchanges along this corridor. At its maximum observed extent, the queue extended back onto Loop 101.

During most observations, westbound congestion was typically found on Loop 202 between SR-143 and I-10/SR-51; average estimated speeds typically ranged from approximately 30 to 50 mph. Factors contributing to the congestion were 1) the lane drop [4 lanes to 3] at 32nd Street, and 2) the lane drop [3 lanes to 2] at I-10/SR-51.

During the peak period, westbound congestion was typically found in the freeway ramp from Loop 202 to I-10; this congestion appeared to be caused or exacerbated by weaving west of the SR-51/Loop 202/I-10 Interchange.

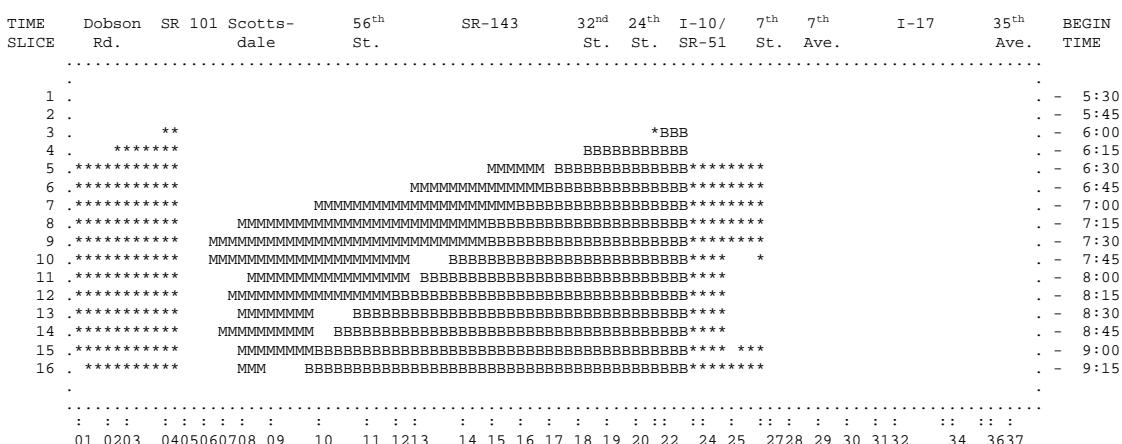
Density Data: LOS F (density greater than 45 vehicles per lane-mile) between 24th Street and 40th Street between 7:30 and 9:00 am; between Mill Avenue and McClintock Drive between 6:30 and 8:30 am; and between McClintock Drive and the Loop 101 Interchange between 7:30 and 8:30 am.

FREQ ANALYSIS

Segment G: Loop 202 WB; Dobson Road to 35th Avenue (on I-10); 5:30 to 9:30 am

Existing Conditions: Bottlenecks currently occur at the Loop 202/SR-51/I-10 interchange and at the Loop 101/Loop 202 interchange. Several physical and operational bottlenecks exist. Physical bottlenecks exist at 7th Street and the Loop 101 interchange. At the Loop 202/SR-51/I-10 interchange, heavy merging and weaving between Loop 202/SR-51 traffic and I-10 traffic significantly reduces the capacity of this freeway segment.

Queue Diagram of Existing Conditions for Segment G:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

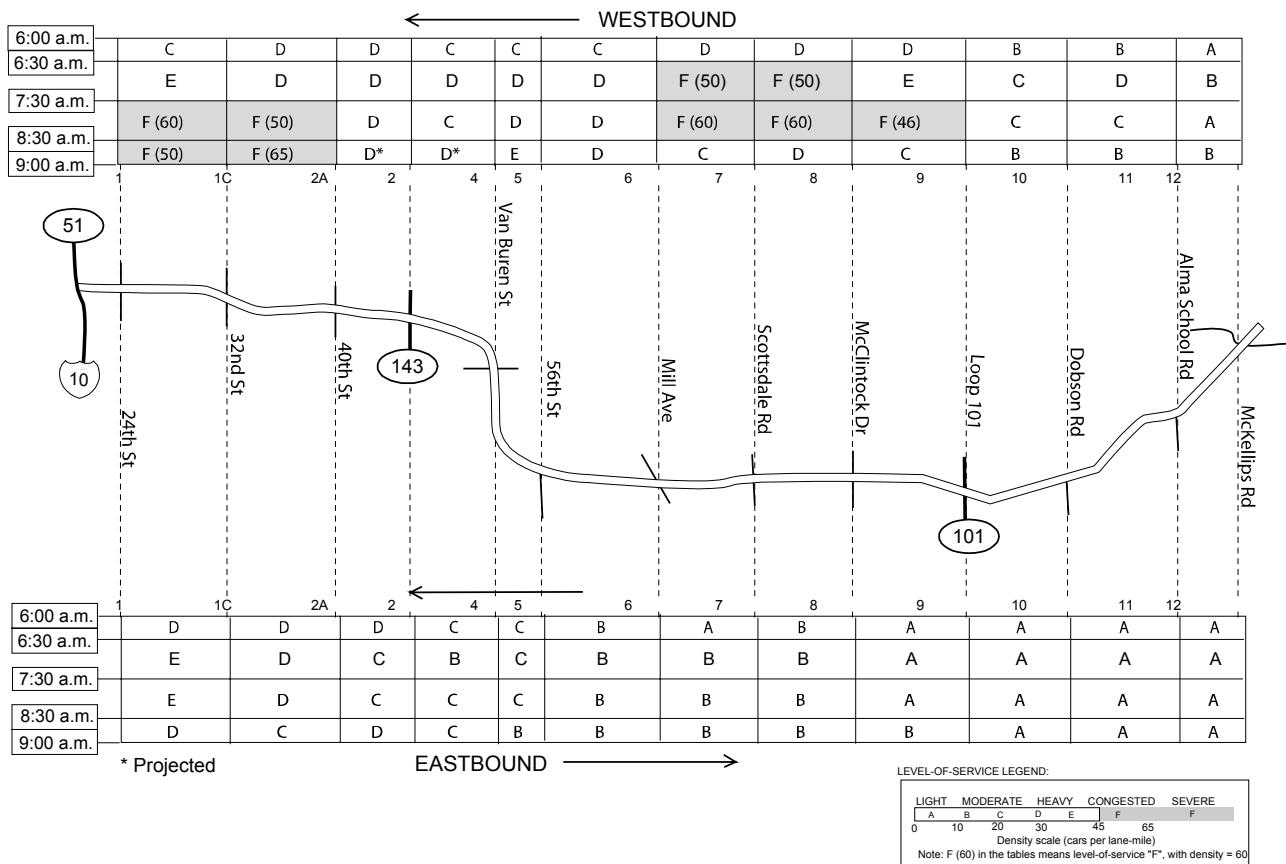
M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

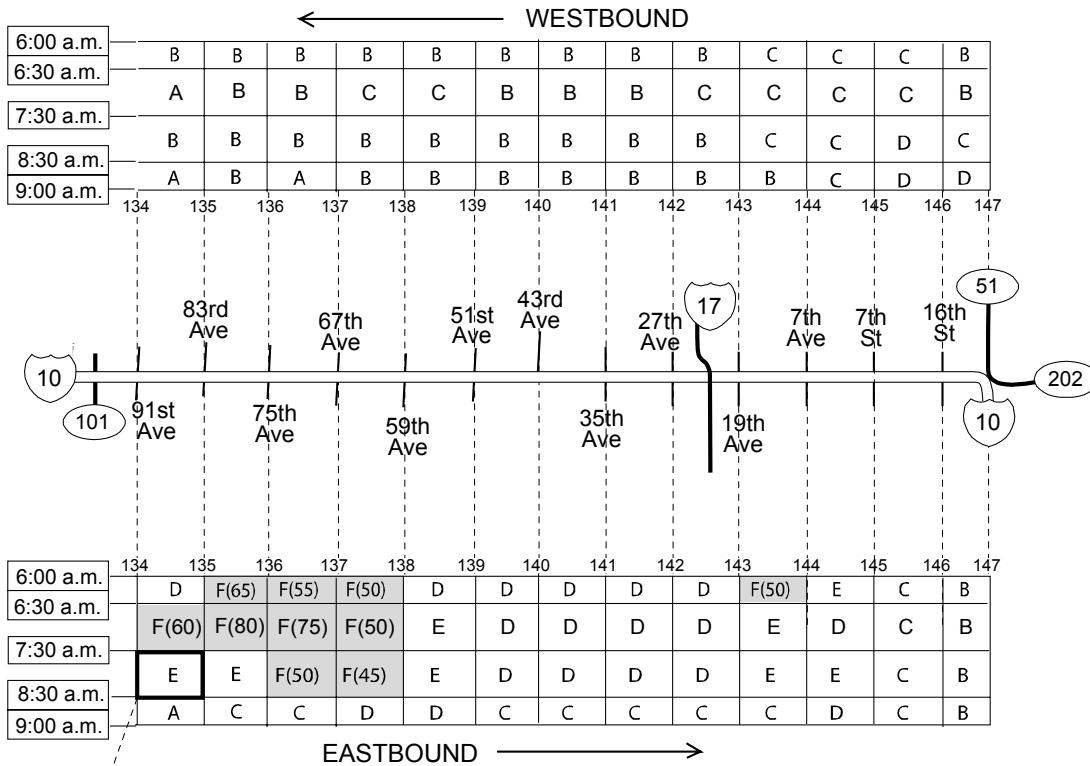
P DENOTES A PRIORITY LANE (HOV).



Loop 202
Morning - Fall 2001



I-10□
(Between 91st Ave & Loop 202 / SR 51)
Morning - Fall 2001



These level-of-service ratings represent the mathematical average of densities, which varied during this hour (congested/not congested); when congested, densities ranged widely, between 90 and 45 pcplpm with corresponding speed estimates of 20 to 50 mph.

LEVEL-OF-SERVICE LEGEND:

LIGHT	MODERATE	HEAVY	CONGESTED	SEVERE
A 0	B 10	C 20	D 30	E 45 F 65

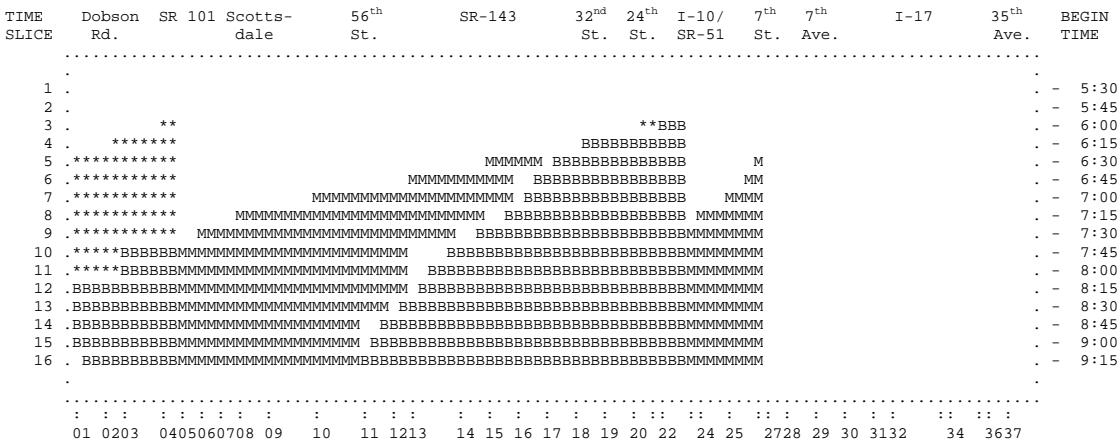
Density scale (cars per lane-mile)

Note: F (60) in the tables means level-of-service "F", with density = 60

Alternative 1: Change the I-10 HOV lane from the Loop 202 interchange to the I-17 interchange into a general purpose lane and allow all traffic to exit at the 3rd Street left off-ramp.

Result: The model results suggest that this alternative may actually worsen the current situation, as vehicles from Loop 202/SR-51 weave across the four I-10 lanes to reach the left side exit at 3rd Street. This alternative will likely reduce weaving and merging at the Loop 202/SR-51/I-10 junction as a portion of I-10 traffic that normally exits at 7th Street uses the 3rd Street exit instead.

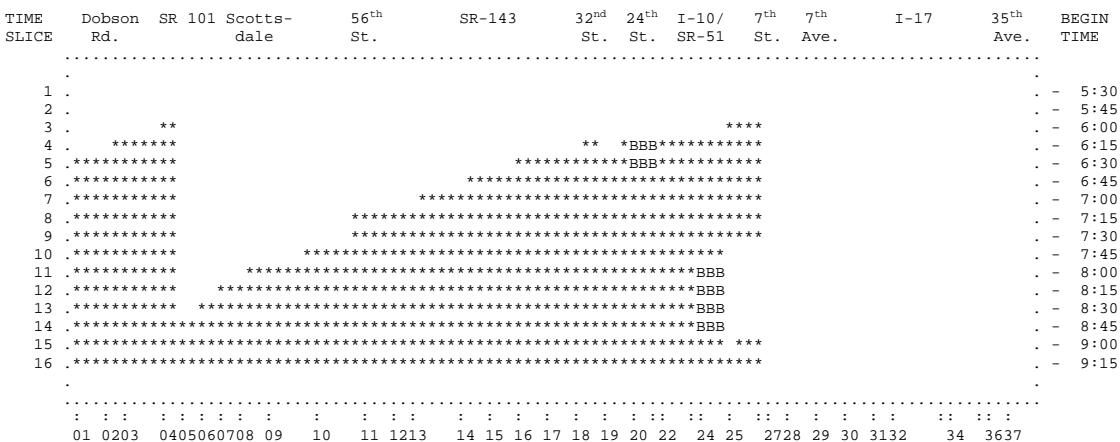
Queue Diagram of Alternative 1 for Segment G:



Alternative 2: Add additional lanes on the southbound to westbound freeway-to-freeway ramps at both the Loop 202/SR-51/I-10 and Loop 202/Loop 101 interchanges.

Result: This alternative significantly reduces delays caused by merging, however, the increased demand entering the freeway exceeds available capacity and produces similar congestion. Overall, freeway travel time decreases slightly.

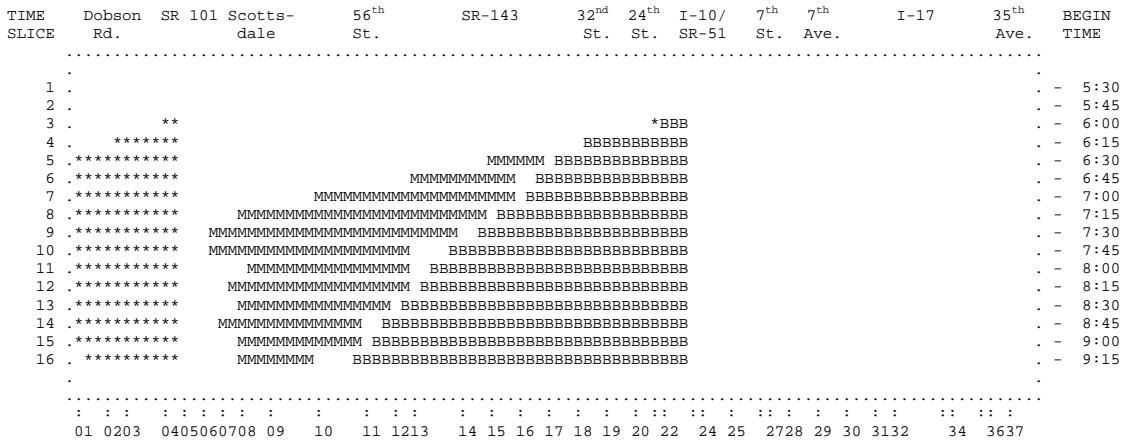
Queue Diagram of Alternative 2 for Segment G:



Alternative 3: Add ramp metering at 900 vehicles per hour throughout the segment.

Result: This alternative has no effect on mainline or ramp congestion. Improved freeway operation could be achieved by tightening down on the ramp metering rates, however this improvement would be offset by increased ramp delays.

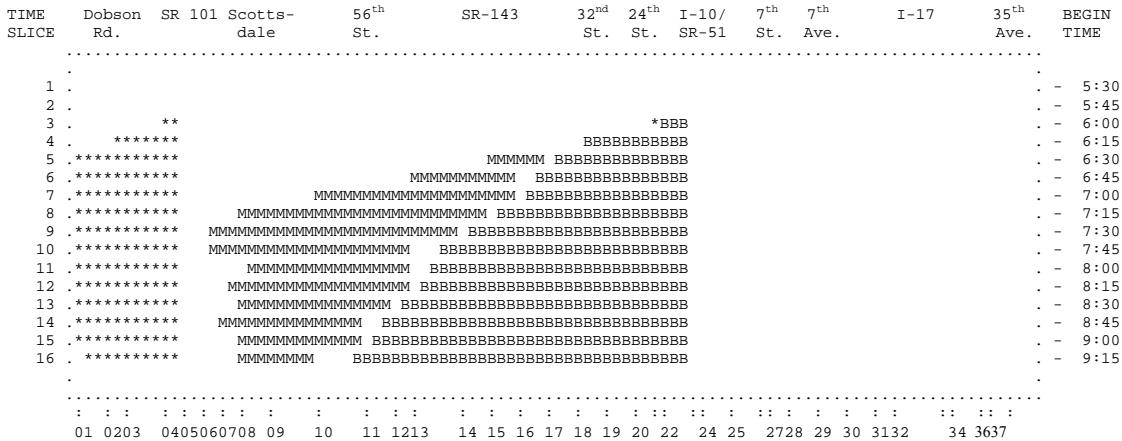
Queue Diagram of Alternative 3 for Segment G:



Alternative 4: Add a general purpose lane from the Loop 202/SR-51/I-10 interchange through the tunnel to the 19th Avenue off-ramp.

Result: This alternative eliminates congestion caused by the 7th Street bottleneck, however, does not improve conditions in the merge/weave area. Overall, travel times remain unchanged.

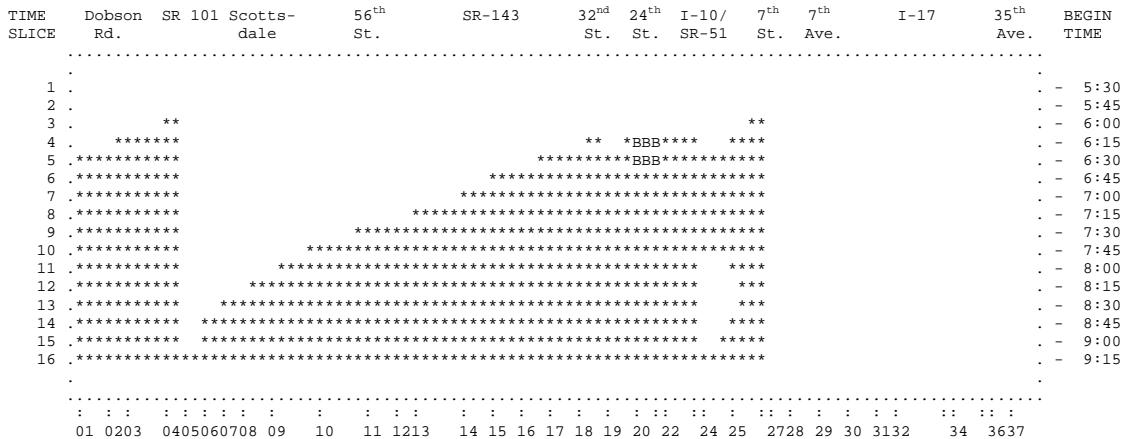
Queue Diagram of Alternative 4 for Segment G:



Alternative 5: Add an outside lane between the Loop 202/SR-51 on-ramp and the 7th Street off-ramp. The two outside lanes would be exit only to 7th Street.

Result: This alternative reduces the merging problem, however, it does not add needed capacity to the mainline. Overall, freeway travel time increases 13%.

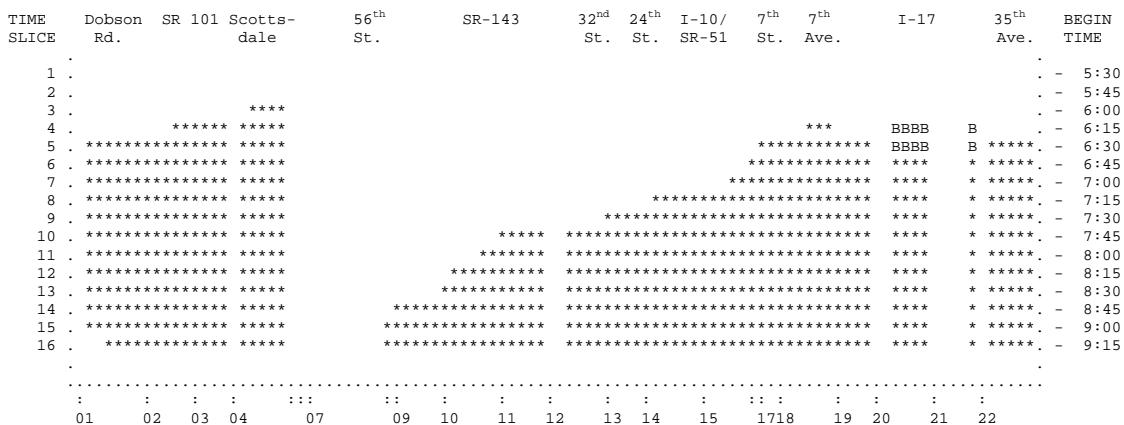
Queue Diagram of Alternative 5 for Segment G:



Alternative 5A: Add an outside lane between the Loop 202/SR-51 on-ramp and the 7th Street off-ramp. The two outside lanes would be exit only to 7th Street. Close the 16th Street on-ramp. The 16th Street on-ramp demand is shifted to the 7th Street on-ramp.

Result: This alternative is slightly better than Alternative 5, in which the 16th Street on-ramp remains open - however overall, freeway travel time remains unchanged when compared with existing conditions. Currently, the 16th Street on-ramp demand is relatively low, probably due to the congested conditions on I-10. As such, eliminating the ramp will not have a significant effect on freeway conditions. Actually, additional ramp delay at the 7th Street on-ramp will likely occur.

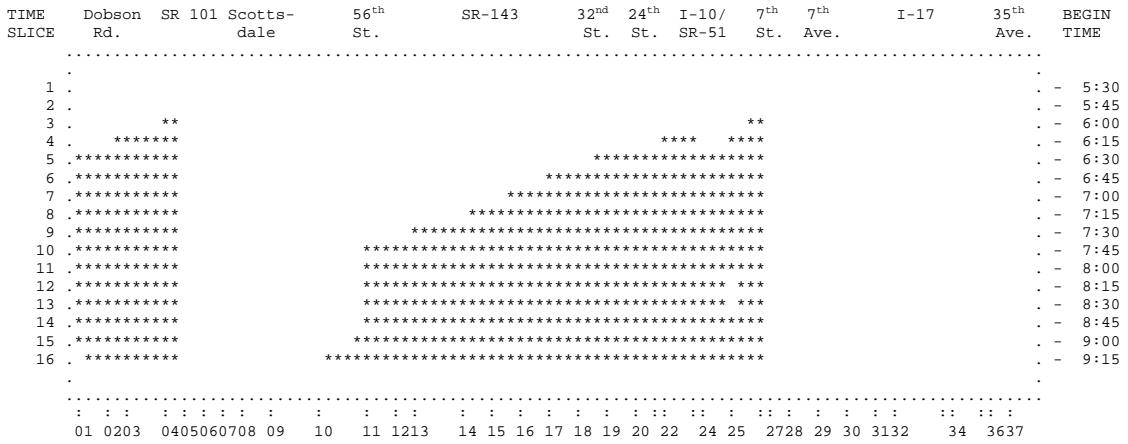
Queue Diagram of Alternative 5A for Segment G:



Alternative 6: Add auxiliary lanes at 32nd Street and 24th Street in addition to the two-lane mandatory off-ramps at 7th Street.

Result: The auxiliary lanes reduce freeway congestion somewhat. Overall, freeway travel time decreases 5%.

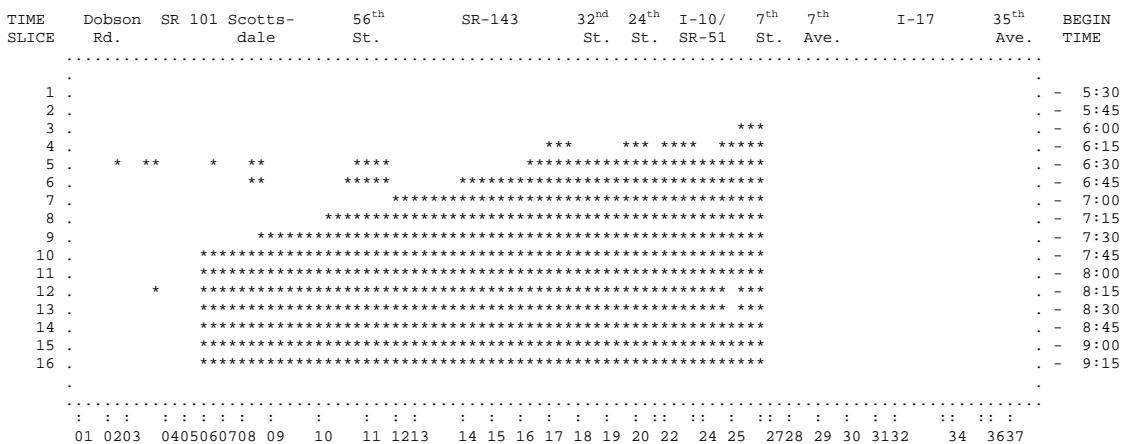
Queue Diagram of Alternative 6 for Segment G:



Alternative 7: Add a third general purpose lane to Loop 202 at the Loop 101/Loop 202 interchange. This is in addition to the auxiliary lanes at 32nd Street and 24th Streets and the two-lane mandatory off-ramps at 7th Street.

Result: This alternative eliminates the congestion at the Loop 101/Loop 202 interchange, however, sends the excess demand downstream where it runs into queuing caused by the 7th Street bottleneck. Overall, freeway travel time decreases 5%.

Queue Diagram of Alternative 7 for Segment G:



Alternative 8: Add an auxiliary lane from McClintock Drive to Scottsdale Road.

Result: This alternative will eliminate some merging problems between Loop 101 and Scottsdale Road - however overall, freeway travel time will remain unchanged.

Queue Diagram of Alternative 8 for Segment G:

TIME SLICE	Dobson Rd.	SR 101 Scotts-dale	56 th St.	SR-143 St.	32 nd St.	24 th St.	I-10/ SR-51	7 th St.	7 th Ave.	I-17	35 th St.	BEGIN Ave.	TIME			
1 .	.	.	.	.	.	.	.	.	.	.	.	.	5:30
2 .	.	.	.	.	.	.	.	.	.	.	.	.	5:45
3 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*	BBBBB. - 6:00			
4 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 6:15			
5 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 6:30			
6 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 6:45			
7 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 7:00			
8 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 7:15			
9 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 7:30			
10 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 7:45			
11 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 8:00			
12 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 8:15			
13 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 8:30			
14 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 8:45			
15 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 9:00			
16 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 9:15			
.			
:	:	:	:	:	:	:	:	:	:	:	:	:	:			
01	02	03	04	07	09	10	11	12	13	14	15	1718	19	20	21	22

Alternative 9: Add a third general purpose lane through the Loop101 interchange, eliminating the existing lane drop.

Result: By increasing the mainline capacity through the interchange, additional demand downstream will create more congestion. Overall, freeway travel time will increase slightly.

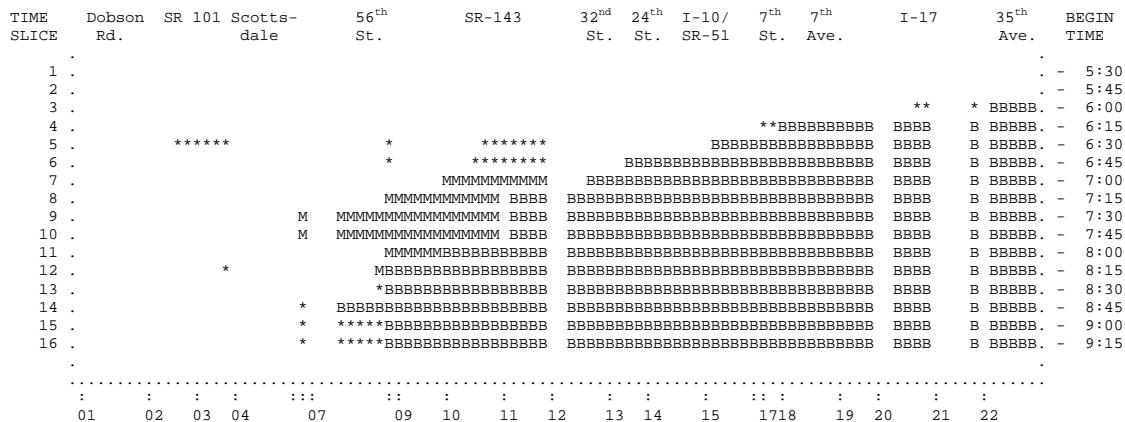
Queue Diagram of Alternative 10 for Segment G:

TIME SLICE	Dobson Rd.	SR 101 Scotts-dale	56 th St.	SR-143 St.	32 nd St.	24 th St.	I-10/ SR-51	7 th St.	7 th Ave.	I-17	35 th St.	BEGIN Ave.	TIME			
1 .	.	.	.	.	.	.	.	.	.	.	.	.	5:30
2 .	.	.	.	.	.	.	.	.	.	.	.	.	5:45
3 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*	BBBBB. - 6:00			
4 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 6:15			
5 .	*****	*	*	*	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 6:30			
6 .	*****	*	*	*	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 6:45			
7 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 7:00			
8 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 7:15			
9 .	*****	M	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 7:30			
10 .	*****	M	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 7:45			
11 .	*****	*	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 8:00			
12 .	*****	*	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 8:15			
13 .	*****	*	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 8:30			
14 .	*****	*	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 8:45			
15 .	*****	***	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 9:00			
16 .	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	B	BBBBB. - 9:15			
.			
:	:	:	:	:	:	:	:	:	:	:	:	:	:			
01	02	03	04	07	09	10	11	12	13	14	15	1718	19	20	21	22

Alternative 10: Add a third general purpose lane through the Loop101 interchange, eliminating the existing lane drop. Add an auxiliary lane from the Loop 101 on-ramp to the Scottsdale Road off-ramp

Result: Similarly to Alternative 10, overall travel time will increase slightly due to the added demand downstream from the Loop 101 interchange. The addition of an auxiliary lane does not provide any significant benefit.

Queue Diagram of Alternative 11 for Segment G:



ANALYSIS SUMMARY – SEGMENT G

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	16110	15561	31670	29.1
Alternative 1	15872	16893	32764	30.2
Alternative 2	24724	5806	30530	17.5
Alternative 3	16072	15628	31700	29.1
Alternative 4	16028	15564	31592	30.3
Alternative 5	22298	10998	33295	20.3
Alternative 5A	20724	11062	31786	22.3
Alternative 6	19175	11447	30622	24.3
Alternative 7	19235	11152	30387	26.1
Alternative 8	16105	15561	31665	29.1
Alternative 9	17953	14593	32546	27.8
Alternative 10	17809	14593	32402	28.1

Conclusions/Recommendations:

1. On this freeway section, the do nothing alternative may be the most appropriate. Improvements that will increase the capacity of either the Loop 101/Loop 202 interchange or the Loop 202/SR-51/I-10 interchange will increase demand and congestion on the downtown section of I-10. The current bottlenecks meter the demand entering this downtown section.
2. Several improvements that can be considered include adding a general purpose lane to westbound I-10 in the tunnel area (7th Street to 7th Avenue) and allowing all traffic to exit I-10 using the left-side 3rd Street off-ramp. Opening up the 3rd Street off-ramp should be carefully evaluated to determine the operational and safety impacts on I-10.
3. Although it was not quantitatively evaluated, reconstruction of the westbound 7th Street off-ramp to increase the capacity at the ramp/7th Street intersection should be considered. Currently, the ramp approach includes dual left-turn and dual right-turn lanes. Even with this approach capacity and the storage provided on the 2-lane ramp, ramp queues still back up onto I-10 during peak periods. Lengthening the dual left and right-turn lanes would add capacity to the ramp approach, allowing a higher number of vehicles to get through the signalized intersection.
4. Adding an auxiliary lane from the Loop101 on-ramp to the Scottsdale Road off-ramp will reduce some of the problems associated with merging.

MAG REGIONAL FREEWAY BOTTLENECK STUDY

PRELIMINARY DRAFT WORKING PAPER FOR:

TASK 6 - BOTTLENECK ANALYSIS WORKING PAPER

TASK 7 - BOTTLENECK IMPROVEMENT SOLUTIONS

TASK 8 - BOTTLENECK IMPROVEMENTS BENEFITS

Part 2

**Draft Date:
October 10, 2002**

Submitted to:
THE MARICOPA ASSOCIATION OF GOVERNMENTS

Prepared by:



OLSSON ASSOCIATES

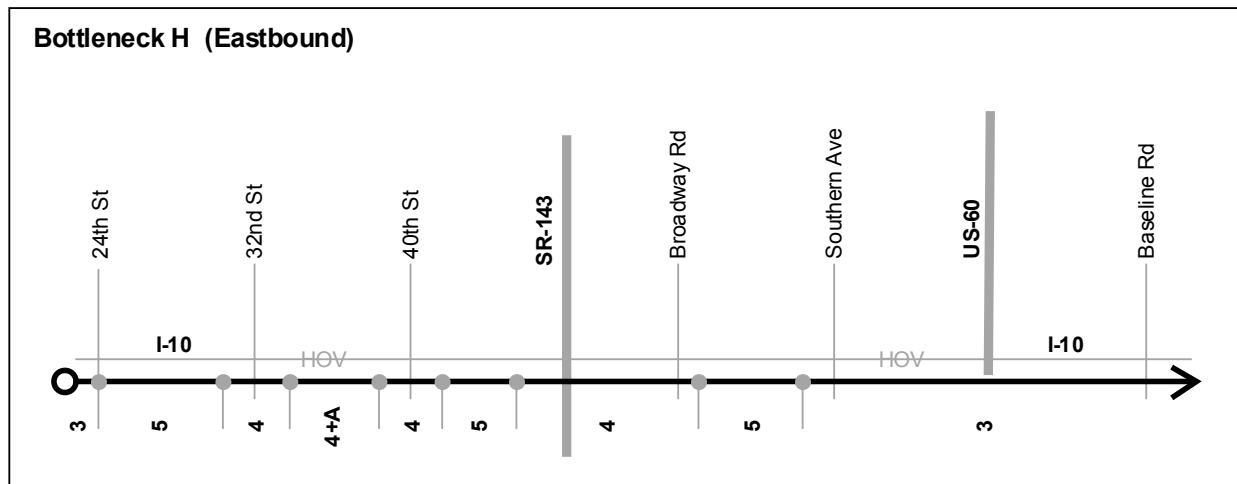
Draft

SEGMENT H
I -10 EASTBOUND: 24TH STREET TO BASELINE ROAD
EVENING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the H bottleneck segment. Lane numbers are shown below the black line. The letter "A" indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the H bottleneck segment reaches a maximum of 240,000 vehicles (vpd) at the intersection of I-10 and Broadway Rd (the "Broadway Curve"). The volume at this location during the PM peak hour is 20,700, which represents 8.6 percent of the total daily volume.

Eastbound Traffic Volumes:

The volumes shown in the table below represent eastbound counts along the H bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	PM Peak Hour Total Volume	PM Peak Hour GP Volume	PM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
I-10 / 32 nd St	8,700	8,100	600	8.1%	1.3%
I-17 / Broadway Rd	10,800	-----	-----	9.2%	-----

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	325	1.36	203	61	50	11
1999	315	1.30	173	62	64	16
2000	286	1.16	174	47	47	18
Total	926	1.28	550	170	161	45

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	325	247	78	0	28
1999	315	243	72	0	27
2000	286	202	84	0	28
Total	926	692	234	0	83

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During the peak period, eastbound congestion was found on I-10 between I-17 and Southern Avenue; average estimated speeds typically ranged from 30 to 50 mph. Contributing factors to the congestion were 1) the lane drop (5 lanes to 4) at University Drive, and 2) vehicles merging into the two right lanes to exit at US-60.

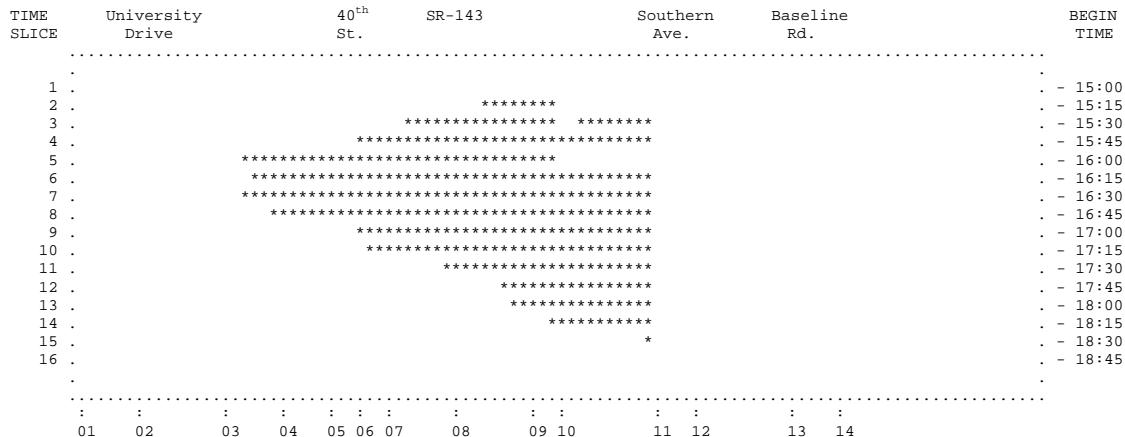
Density Data: (no data collected after 6:00 pm): Level of Service F (density greater than 45 vehicles per lane-mile) between University Drive and 40th Street between 4:00 and 6:00 pm and between 40th Street and the US-60 exit-ramp between 5:00 and 6:00 pm.

FREQ ANALYSIS

Segment H: I-10 EB; 24th Street to Baseline Road; 3:00 to 7:00 pm

Existing Conditions: Existing bottlenecks occur at Broadway Road and the I-10/US-60 interchange. The congestion extends from US-60 to University Drive. The bottleneck at I-10/US-60 is caused by merging traffic from the upstream SR-143 on-ramp and merging/weaving at the US-60 off-ramp. The recent construction of the HOV flyover ramp, connecting I-10 with US-60 has eliminated some of the merging problem.

Queue Diagram of Existing Conditions for Segment H:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

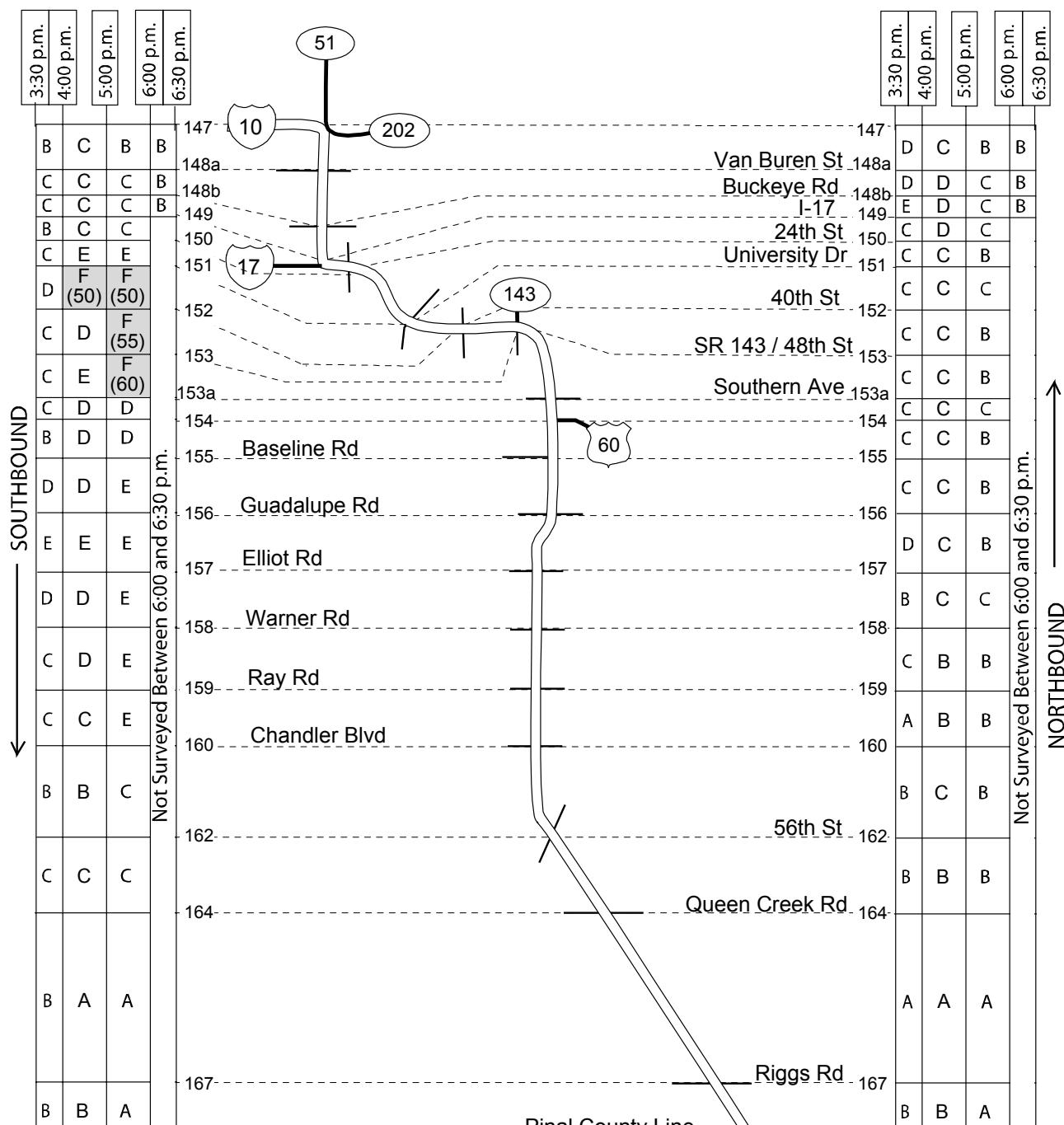
ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

I-10
(Between SR 202 / SR 51 & Chandler Blvd)
Evening - Fall 2001



LEVEL-OF-SERVICE LEGEND:						
LIGHT	MODERATE	HEAVY	CONGESTED	SEVERE		
A	B	C	D	E	F	
0	10	20	30	45	65	
Density scale (cars per lane-mile)						
Note: F (60) in the tables means level-of-service "F", with density = 60						

Alternative 1: Add a collector-distributor road from SR-143 to Baseline Road.

Result: Removing the merging/weaving problem created by the traffic entering at the SR-143 on-ramp eliminates the bottleneck at the I-10/US-60 interchange. Overall mainline travel time decreases 38%. A detailed analysis of collector-distributor road operation is needed to determine overall freeway impacts.

Queue Diagram of Alternative 1 for Segment H:

TIME SLICE	University Drive	40 th St.	SR-143	Southern Ave.	Baseline Rd.	BEGIN TIME
1 .	.	.	.	.	.	. - 15:00
2 .	.	.	.	.	.	. - 15:15
3 .	.	.	.	.	.	. - 15:30
4 .	.	.	.	.	.	. - 15:45
5 .	.	****	.	.	.	. - 16:00
6 .	.	.	.	.	.	. - 16:15
7 .	.	.	.	.	.	. - 16:30
8 .	.	.	.	.	.	. - 16:45
9 .	.	.	.	.	.	. - 17:00
10 .	.	.	.	.	.	. - 17:15
11 .	.	.	.	.	.	. - 17:30
12 .	.	.	.	.	.	. - 17:45
13 .	.	.	.	.	.	. - 18:00
14 .	.	.	.	.	.	. - 18:15
15 .	.	.	.	.	.	. - 18:30
16 .	.	.	.	.	.	. - 18:45
.
01 :	02 :	03 :	04 :	05 :	06 :	07 :
:	:	:	:	:	:	:
08 :	09 :	10 :				
11 :	12 :					
13 :	14 :					

Alternative 2: Add a collector-distributor road from 24th Street to Baseline Road.

Result: Similar results as Alternative 1. Overall mainline travel time decreases 43%. A detailed analysis of collector-distributor road operation is needed to determine overall freeway impacts.

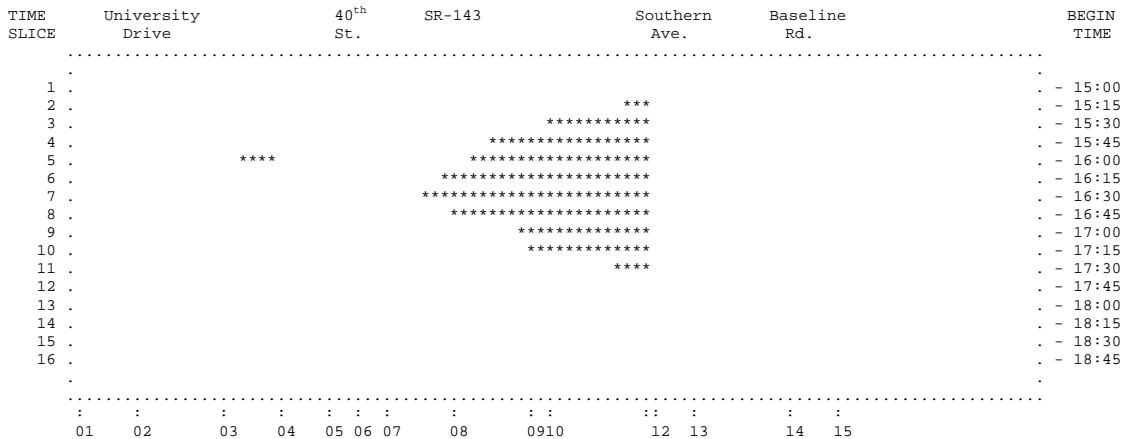
Queue Diagram of Alternative 2 for segment H:

TIME SLICE	University Drive	40 th St.	SR-143	Southern Ave.	Baseline Rd.	BEGIN TIME
1 .	.	.	.	.	.	. - 15:00
2 .	.	.	.	.	.	. - 15:15
3 .	.	.	.	.	.	. - 15:30
4 .	.	.	.	.	.	. - 15:45
5 .	.	.	.	.	.	. - 16:00
6 .	.	.	.	.	.	. - 16:15
7 .	.	.	.	.	.	. - 16:30
8 .	.	.	.	.	.	. - 16:45
9 .	.	.	.	.	.	. - 17:00
10 .	.	.	.	.	.	. - 17:15
11 .	.	.	.	.	.	. - 17:30
12 .	.	.	.	.	.	. - 17:45
13 .	.	.	.	.	.	. - 18:00
14 .	.	.	.	.	.	. - 18:15
15 .	.	.	.	.	.	. - 18:30
16 .	.	.	.	.	.	. - 18:45
.
01 :	02 :	03 :	04 :	05 :	06 :	07 :
:	:	:	:	:	:	:
08 :	09 :	10 :				
11 :	12 :					
13 :	14 :					

Alternative 3: Include the left side HOV ramp connecting the southbound I-10 to eastbound US-60 HOV lanes. This ramp has been completed and is currently in operation.

Result: This alternative reduces the congestion created by the merging/weaving. Overall freeway travel time decreases 8%.

Queue Diagram of Alternative 3 for Segment H:



ANALYSIS SUMMARY – SEGMENT H

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	5987	6528	12515	42.7
Alternative 1	3642	4201	7844	66.2
Alternative 2	3352	3865	7217	69.8
Alternative 3	5015	6529	11544	50.8

Conclusions/Recommendations:

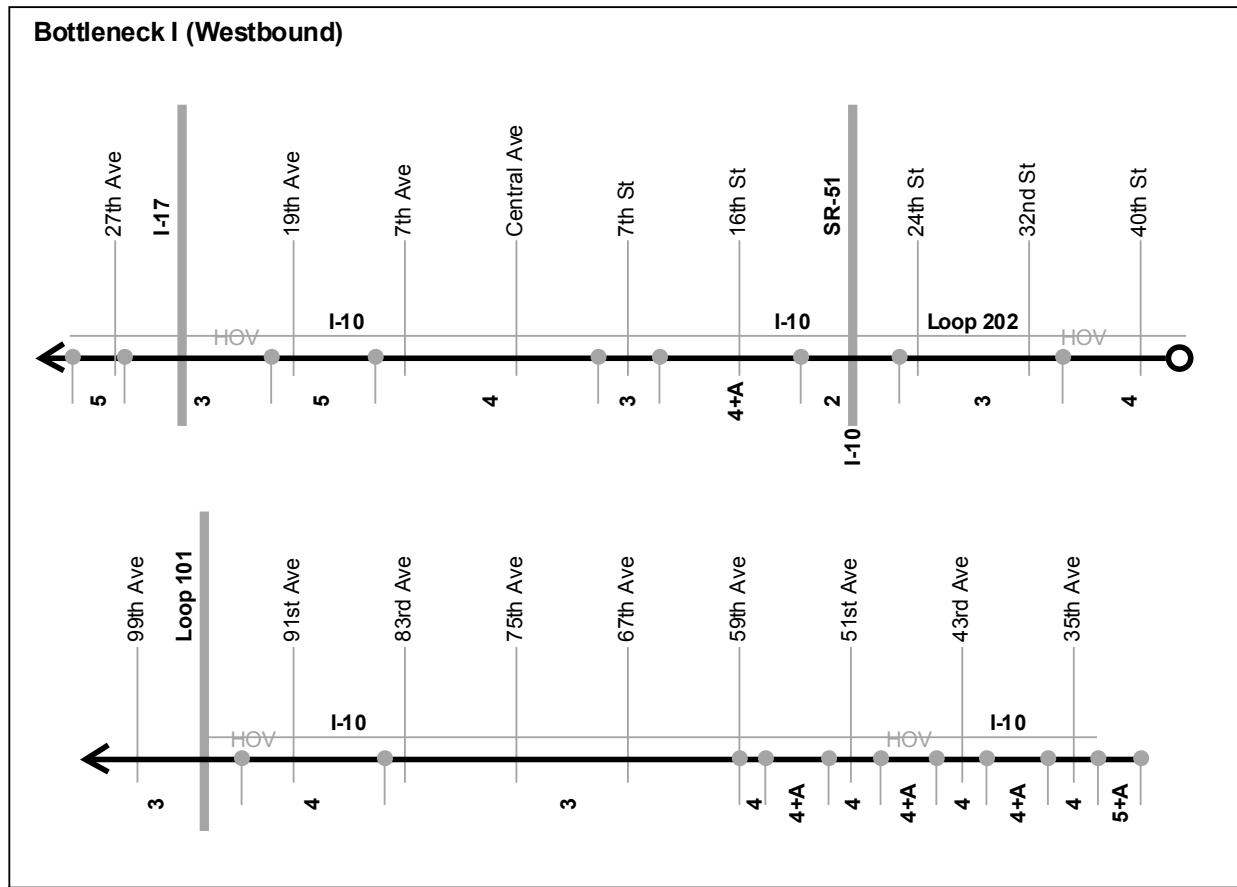
1. The addition of a collector-distributor road from SR-143 to Baseline Road will significantly reduce the congestion created by merging/weaving between SR-143 and US-60. The on-going collector-distributor road study will provide a detailed assessment of the impacts on mainline traffic flow, collector-distributor road operations, and access.

SEGMENT I
I-10 WESTBOUND: 40TH STREET (ON LOOP 202) TO 99TH AVENUE
EVENING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the I bottleneck segment. Lane numbers are shown below the black line. The letter "A" indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along this bottleneck segment reaches a maximum of 259,000 vehicles (vpd) at the intersection of I-10 and 7th Street. The volume at this location during the PM peak hour is 16,200 for General Purpose lanes and 3,000 for HOV lanes. These combined peak hour volumes represent 7.4% of the total daily volume.

Westbound Traffic Volumes:

The volumes shown in the table below represent westbound counts along the I bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	PM Peak Hour Total Volume	PM Peak Hour GP Volume	PM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
Loop 202 / 32 nd St	7,200	7,100	100	7.4%	0.4%
I-10 / 16 th St	9,700	8,100	1,600	7.1%	2.1%
I-10 / 7 th Av	7,400	5,800	1,600	6.6%	-----
I-10 / 31 st Av	10,100	8,800	1,300	9.0%	3.6%
I-10 / 51st Av	5,000	4,500	500	6.1%	-----
I-10 / 75 th Av	7,400	6,500	900	9.5%	3.0%

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	1177	2.16	896	131	119	31
1999	1050	1.84	801	122	94	33
2000	1239	2.07	914	175	122	28
Total	3466	2.02	2611	428	335	92

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	1177	885	289	3	46
1999	1050	773	274	3	49
2000	1239	867	368	4	73
Total	3466	2525	931	10	168

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on pages I-5 and I-6.

Observations: During most observations, westbound congestion was typically found in Loop 202 between 32nd Street and I-10/SR-51; average estimated speeds typically ranged from approximately 25 to 50 mph. This congestion appeared to be caused or exacerbated by the lane drop [3 lanes to 2] at I-10 / SR-51.

Before 4:30 pm, a short zone of westbound congestion was found in I-10 between SR-51/Loop 202 and 7th Street; average estimated speeds along this segment typically ranged from 30 to 50 mph. This congestion appeared to be caused or exacerbated by the lane drops [5 lanes to 4 and 4 lanes to 3] in the vicinity of 7th Street.

During the peak period, westbound congestion was found in I-10 between the vicinity of I-17 and 67th Avenue. Contributing factor to the congestion were 1) the lane drop [5 lanes to 4] at 35th Avenue and 2) the lane drop [4 lanes to 3] at 59th Avenue. Average speeds along this segment typically ranged from approximately 20 to 40 mph.

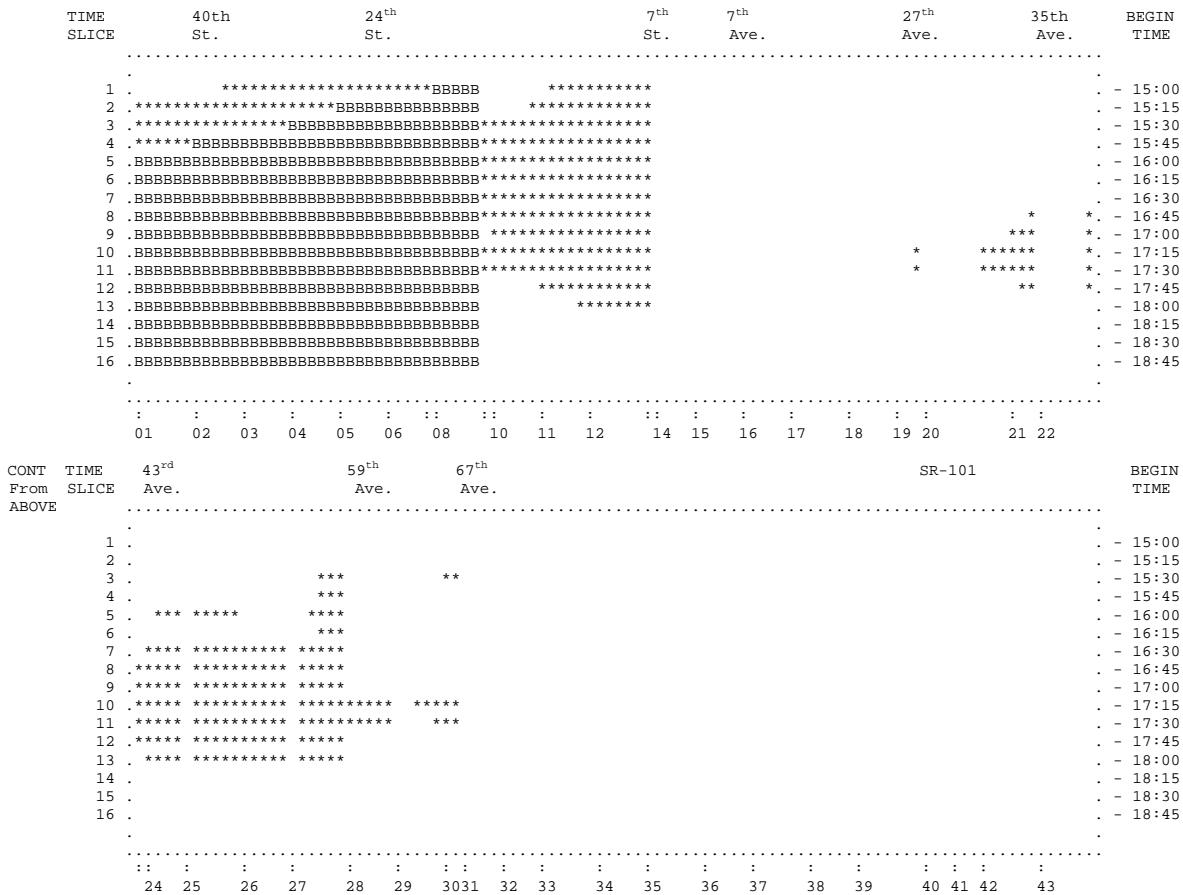
Density Data: Level of Service F (density greater than 45 vehicles per lane-mile) between 24th Street and 32nd Street between 3:30 and 4:00 pm, and again between 5:00 and 6:00 pm; between Van Buren Street and 56th Street between 5:00 and 6:30 pm; between 56th Street and McClintock Drive between 3:30 and 6:30 pm; between 67th Avenue and 59th Avenue between 3:30 and 4:00 pm and again between 5:00 and 6:00 pm; between 59th Avenue and 51st Avenue between 3:30 and 6:30 pm; between 51st Avenue and 19th Avenue between 5:00 and 6:00 pm; and between 7th Street and 16th Street between 3:30 and 4:00 pm.

FREQ ANALYSIS

Segment I: I-10 WB; 40th Street to 99th Avenue; 3:00 to 7:00 pm

Existing Conditions: Bottlenecks currently exist at the Loop 202/SR-51/I-10 interchange, 7th Street, 35th Avenue, 59th Avenue and 67th Avenue. Merging and weaving of traffic between the westbound Loop 202/SR-51 traffic and I-10 traffic are major contributors to congestion.

Queue Diagram of Existing Conditions for Segment I:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

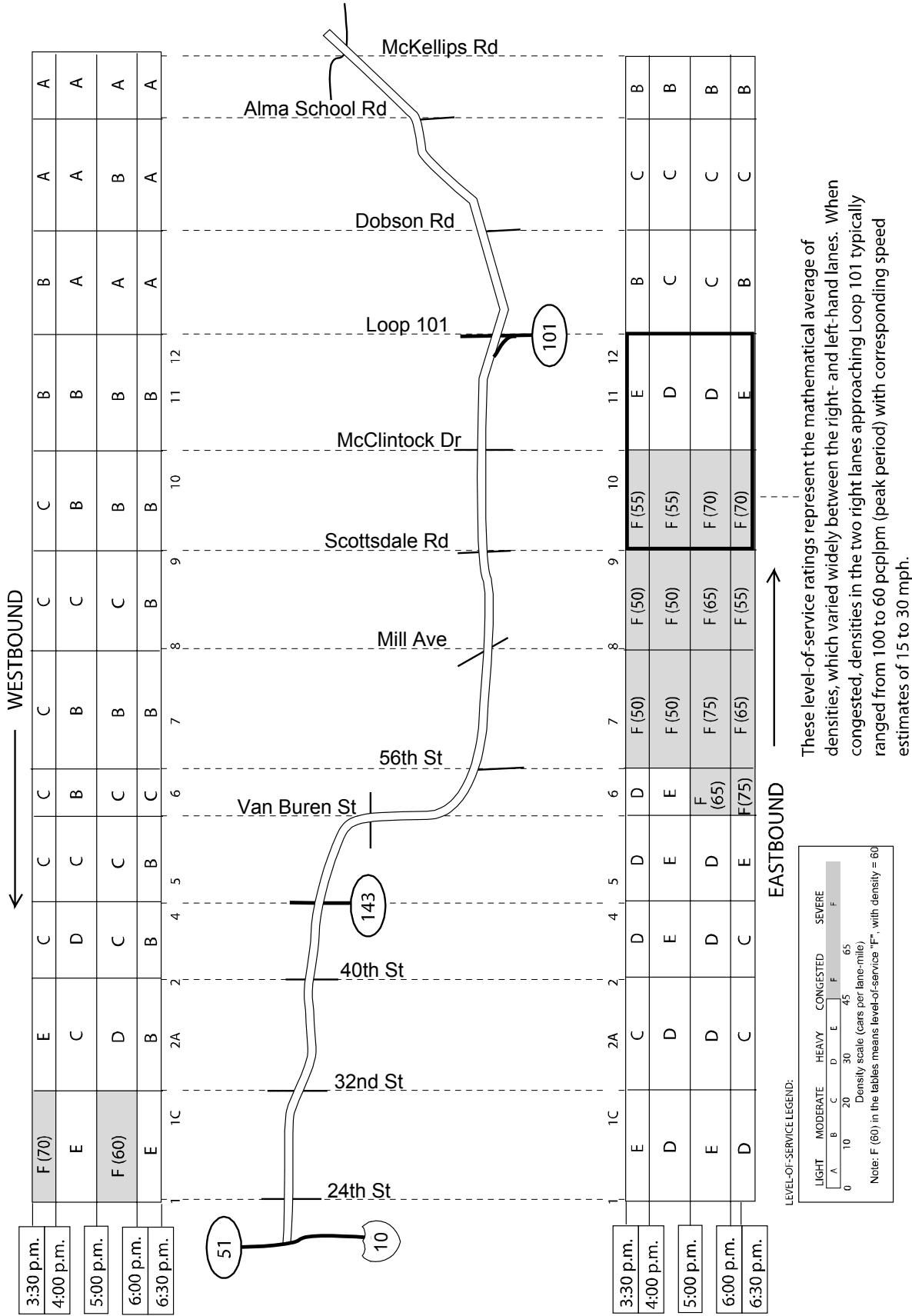
ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

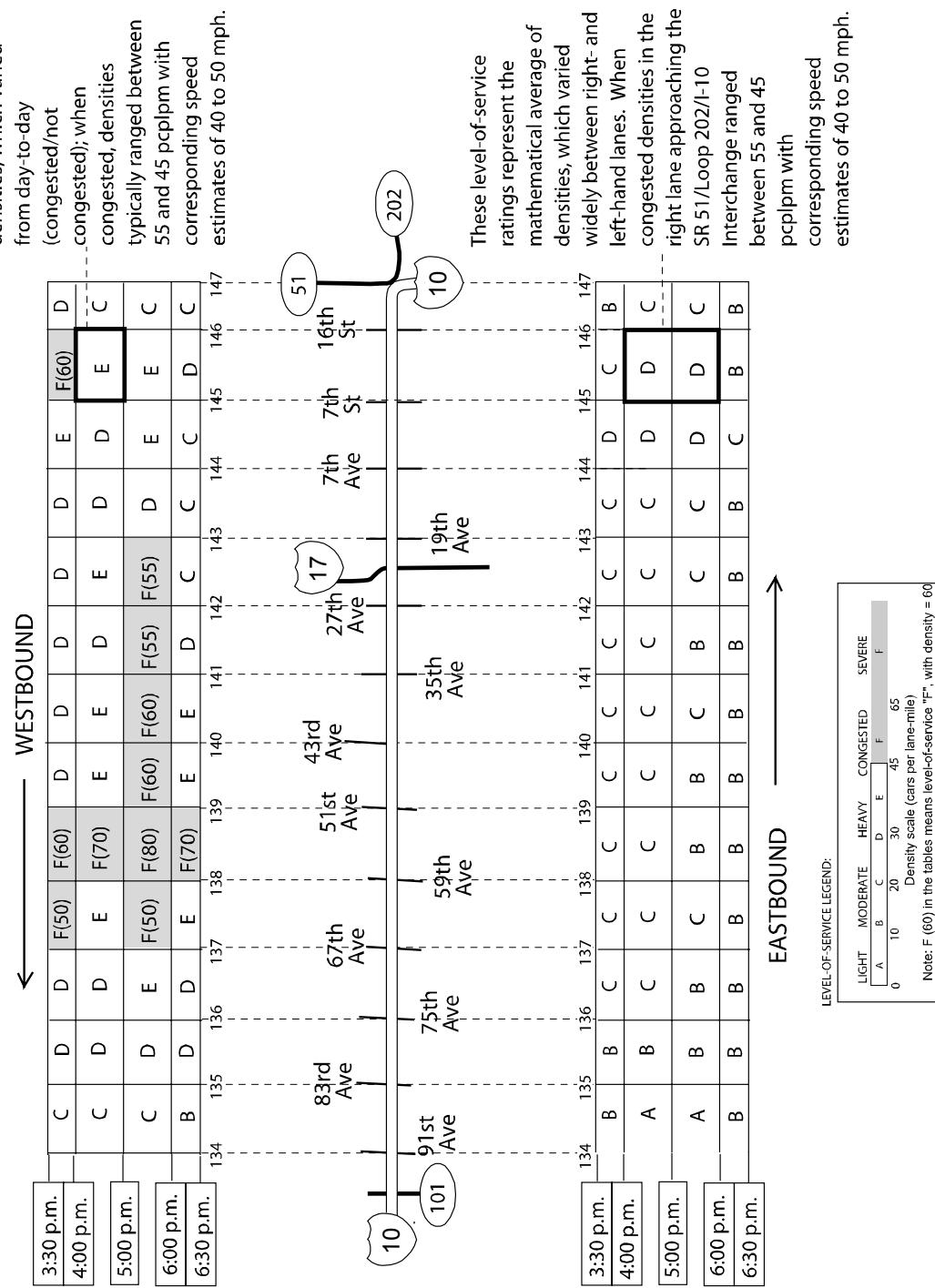
B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

Loop 202 Evening - Fall 2001



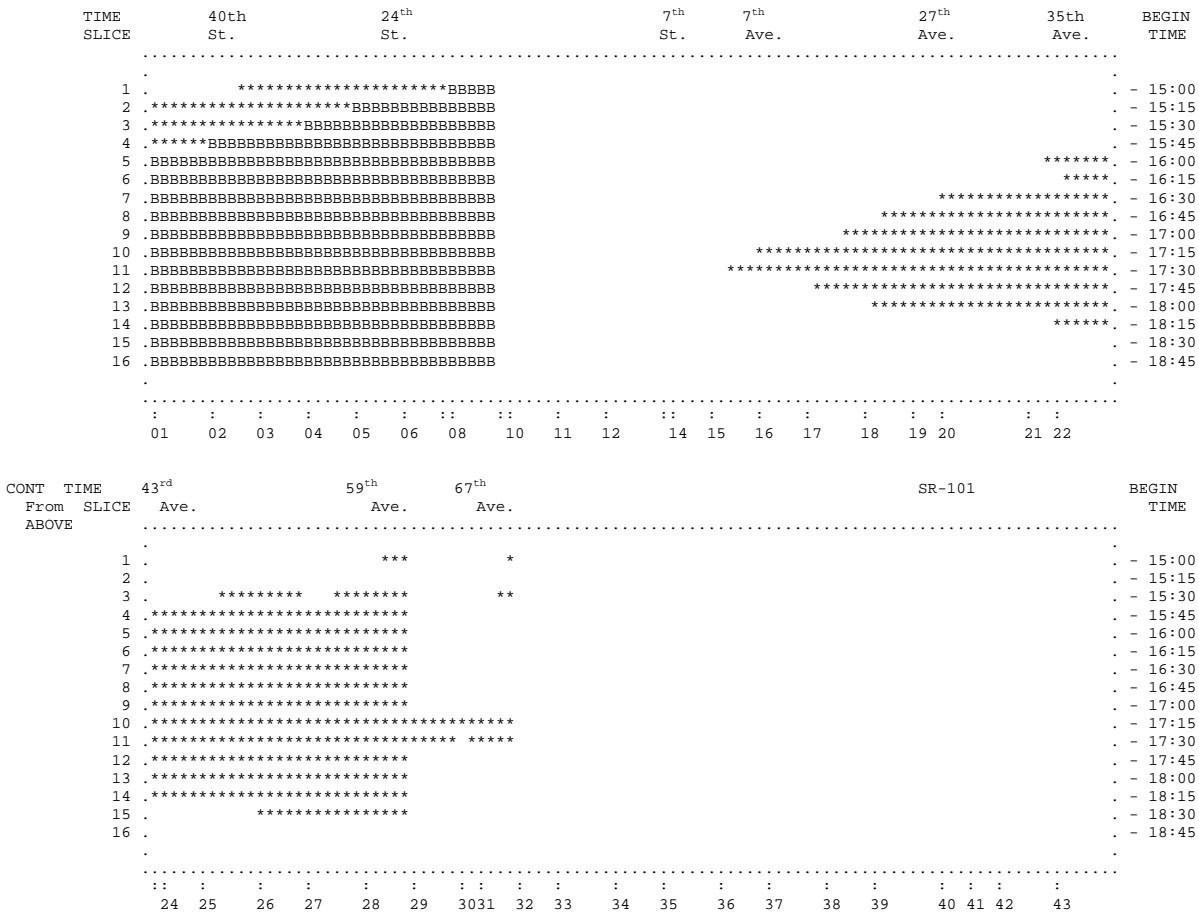
I-10 □
(Between 91st Ave & Loop 202 / SR 51)
Evening - Fall 2001



Alternative 1: Change the I-10 HOV lane from the Loop 202 interchange to the I-17 interchange into a general purpose lane and allow all traffic to exit at the 3rd Street left exit-ramp.

Result: This alternative eliminated congestion caused by the 7th Street bottleneck, however, the resulting increase in demand downstream creates worse congestion at the 59th Avenue and 35th Avenue bottlenecks. Overall, freeway travel time increases slightly.

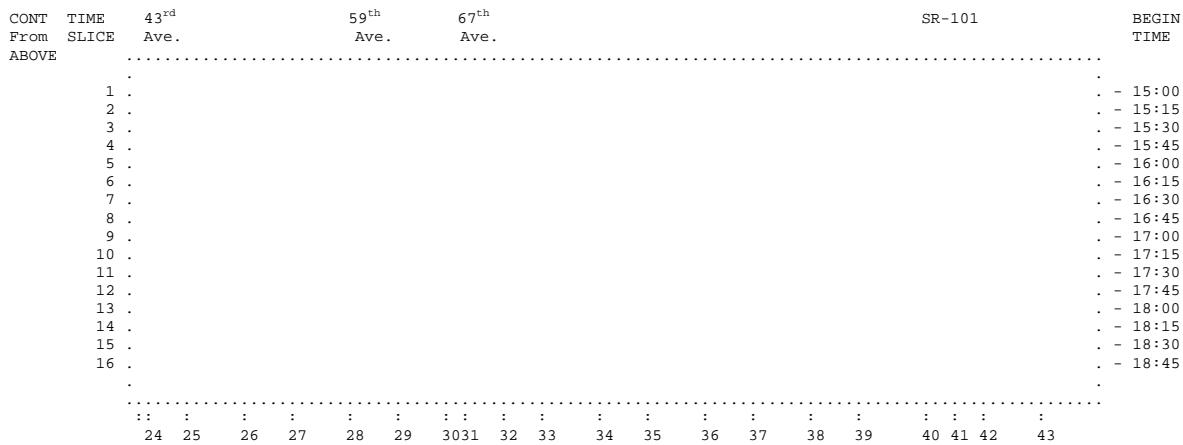
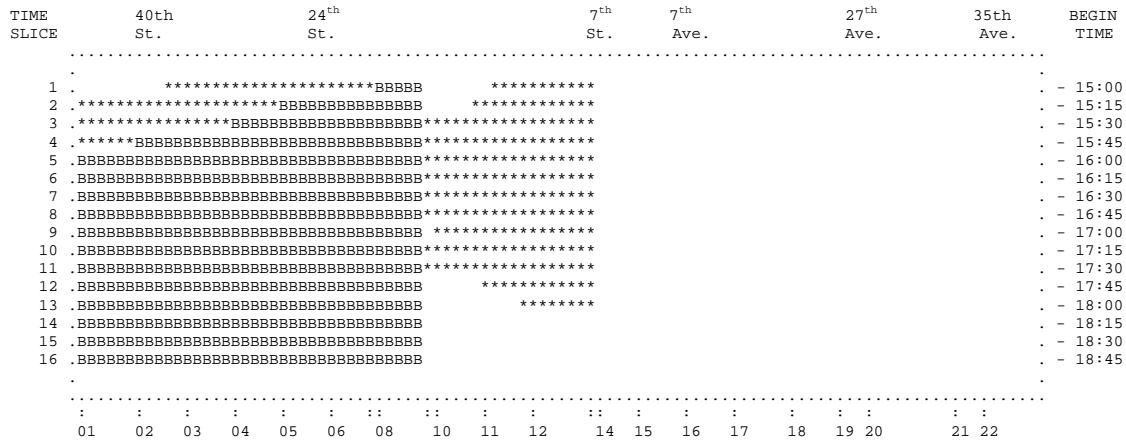
Queue Diagram of Alternative 1 for Segment I:



Alternative 2: Add an additional general purpose lane and auxiliary lanes between 35th Avenue and 67th Avenue.

Result: This alternative eliminates congestion at these two bottlenecks. Overall, freeway travel time decreases 4%.

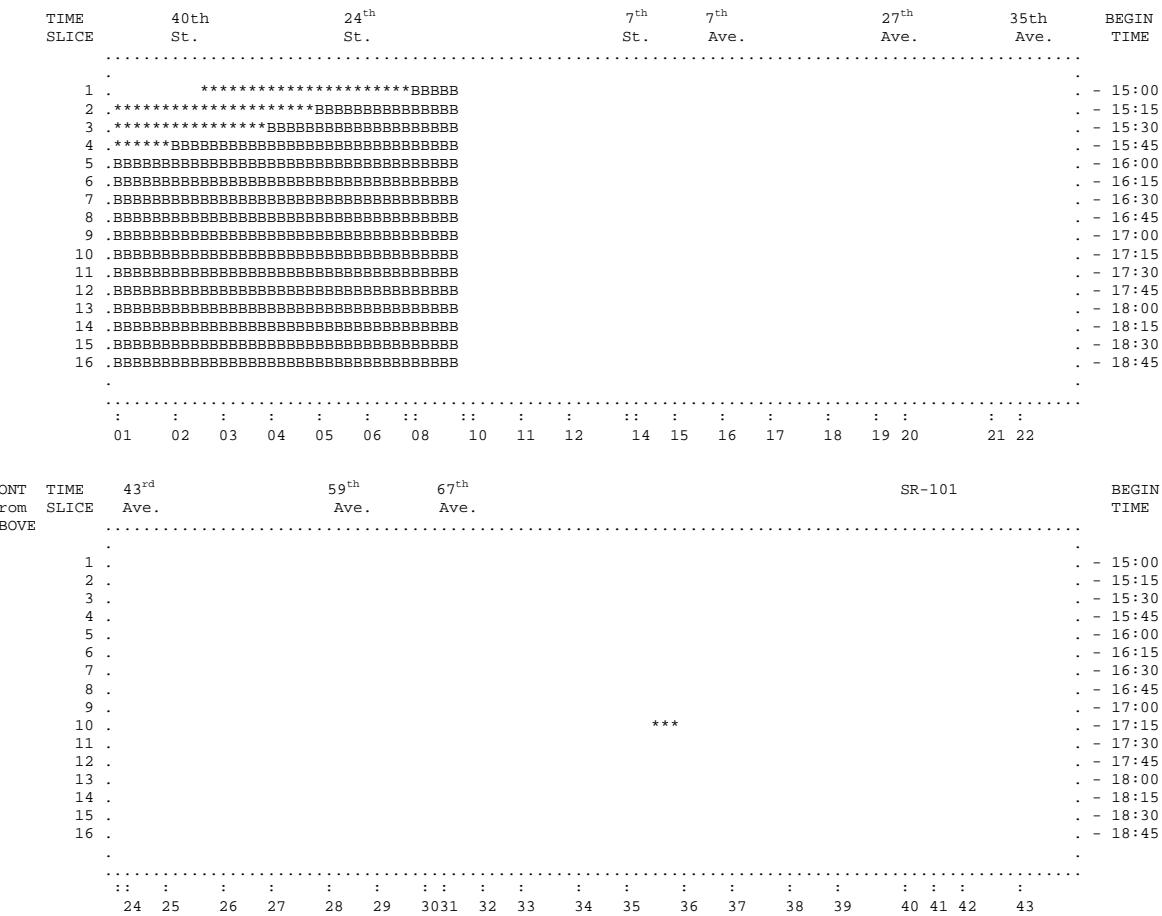
Queue Diagram of Alternative 2 for Segment I:



Alternative 3: Combine Alternative 1 and Alternative 2: convert the downtown HOV lane to a general purpose lane with access to the 3rd Street off-ramp and add a general purpose lane and auxiliary lanes between 35th Avenue and 67th Avenue

Result: Congestion caused by bottlenecks at 7th Street, 35th Avenue and 67th Avenue is eliminated. Congestion associated with the Loop 202/SR-51/I-10 remains. Overall, freeway travel times decrease 9%.

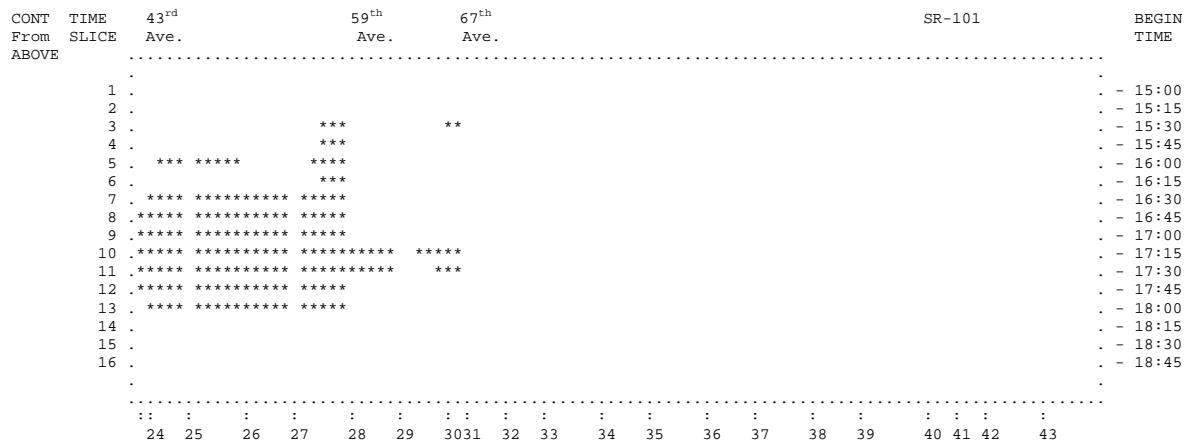
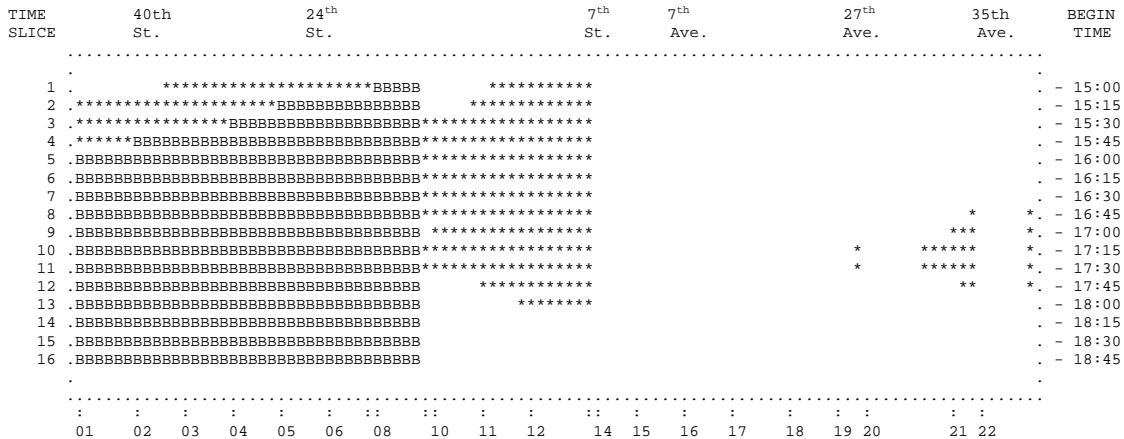
Queue Diagram of Alternative 3 for Segment I:



Alternative 4: Add an additional general purpose lane and auxiliary lanes between 59th Avenue and 91st Avenue, as well as an additional through lane between 7th Street and 7th Avenue.

Result: This alternative improved traffic flow at the 59th Avenue bottleneck somewhat. Overall, freeway travel time remains essentially unchanged.

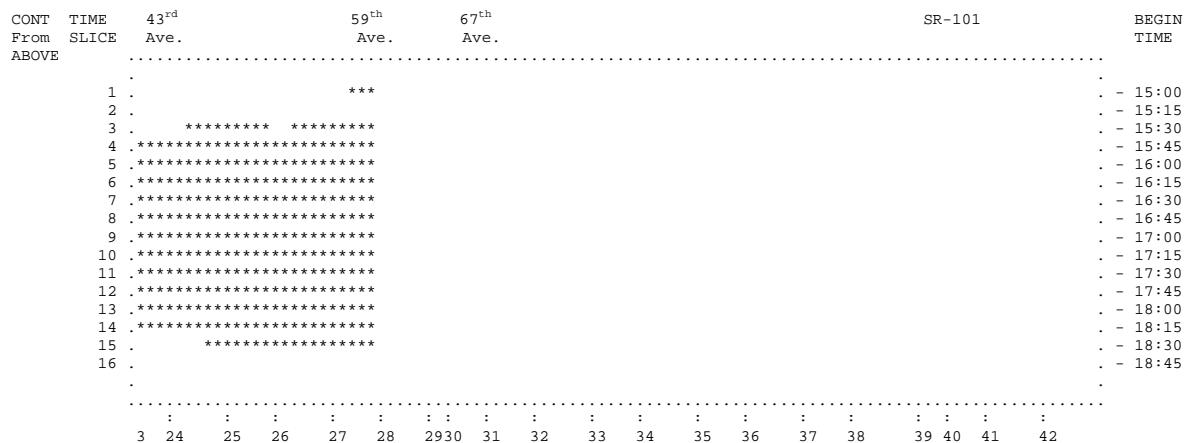
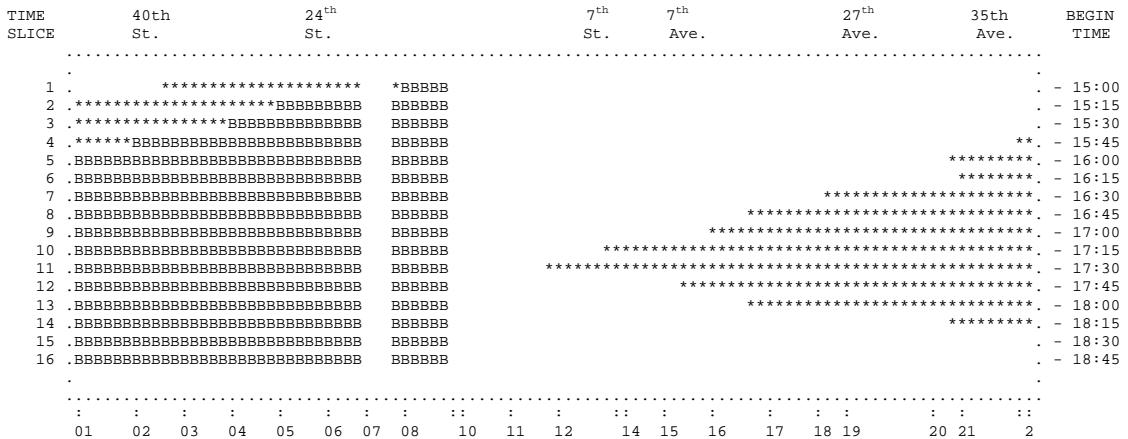
Queue Diagram of Alternative 4 for Segment I:



Alternative 5: Add an additional general purpose lane between 7th Street and 7th Avenue and construct a 4+1+A cross section from 59th Avenue to 83rd Avenue.

Result: This alternative cleared up the 7th Street bottleneck moving traffic downstream, thus increasing the delays at the 59th Avenue bottleneck.

Queue Diagram of Alternative 5 for Segment I:



ANALYSIS SUMMARY – SEGMENT I

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	14344	19345	33689	34.1
Alternative 1	15105	19077	34182	35.1
Alternative 2	13142	19345	32486	37.3
Alternative 3	11827	19079	30906	44.7
Alternative 4	14177	19345	33522	34.6
Alternative 5	14812	19087	33899	34.3

Conclusions/Recommendations:

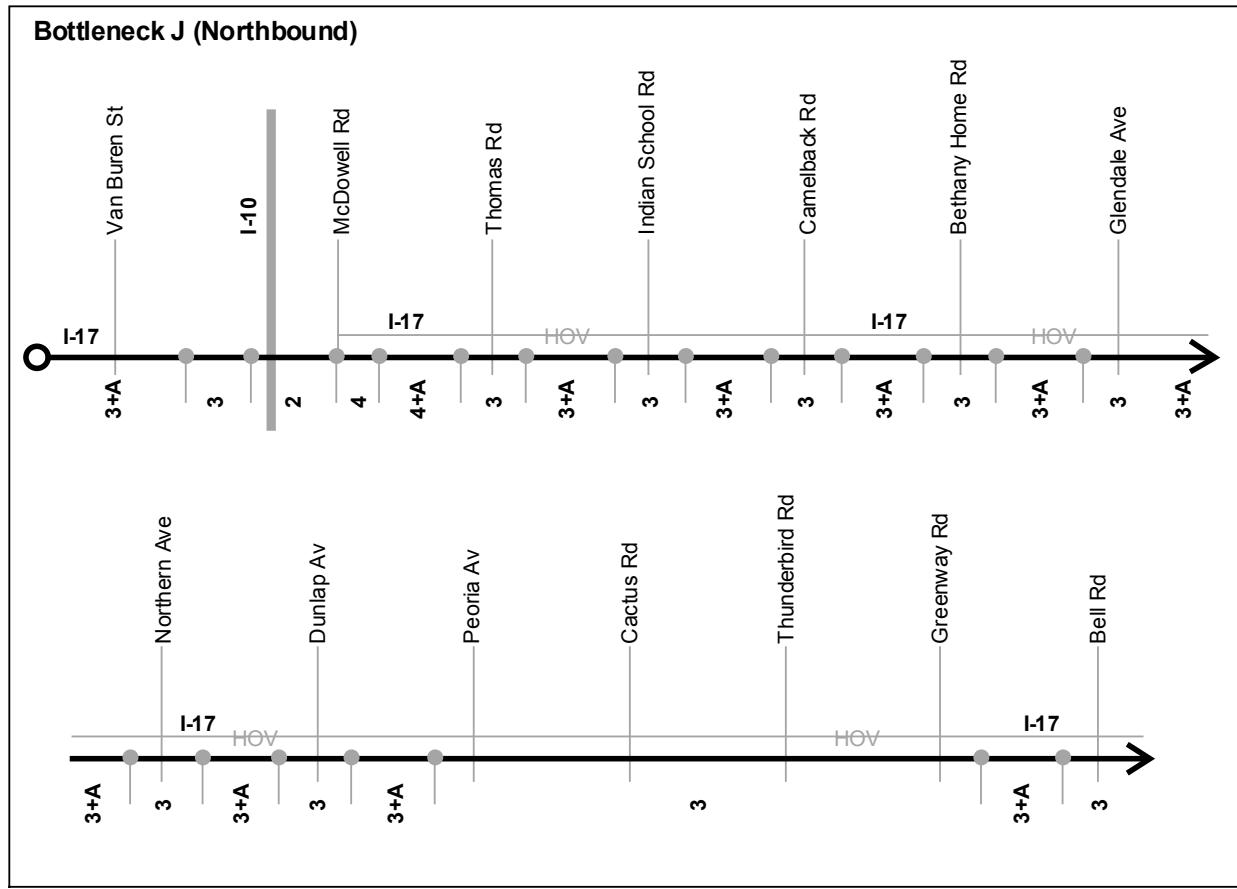
1. Analysis of various alternatives indicates that significant improvements are needed to produce an appreciable reduction in congestion. These improvements include adding additional general purpose capacity in the tunnel segment (7th Street to 7th Avenue) and widening the freeway section from 35th Avenue to 67th Avenue to a 5+1+A cross section.
2. Improvements to increase the capacity at the Loop 202/SR-51/I-10 interchange will increase downstream demand and should not be considered without implementing the capacity enhancements at the 7th Street and 67th Avenue bottlenecks.

SEGMENT J
I-17 NORTHBOUND: VAN BUREN STREET TO BELL ROAD
EVENING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the J bottleneck segment. Lane numbers are shown below the black line. The letter "A" indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the J bottleneck segment reaches a maximum of 208,000 vehicles (vpd) along I-17 at Campbell Rd. The volume at this location during the PM peak hour is 13,900, which represents 6.7% of the total daily volume.

Northbound Traffic Volumes:

The volumes shown in the table below represent northbound counts along the J bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	PM Peak Hour Total Volume	PM Peak Hour GP Volume	PM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
I-17 / Van Buren St	6,600	-----	-----	10%	-----
I-17 / Campbell Rd	7,300	5,900	1,400	7.3%	0.9%
I-17 / Glendale Av	7,700	6,500	1,200	7.8%	1.7%
I-17 / Peoria Av	7,100	-----	-----	7.3%	-----
I-17 / Thunderbird Rd	6,700	5,400	1,300	8.3%	1.0%

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	846	2.05	579	121	121	25
1999	790	1.87	526	129	115	20
2000	908	2.10	571	176	128	33
Total	2544	2.0	1676	426	346	78

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	846	609	237	0	42
1999	790	558	231	1	49
2000	908	648	259	1	70
Total	2544	1815	727	2	161

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During most observations, northbound congestion was found on I-17 between Thomas Road and Northern Avenue. Congestion appeared to be caused or exacerbated by weaving and merging associated with the interchanges along this corridor. Average estimated speeds typically ranged from approximately 20 to 40 mph.

While congestion persisted north of Northern Avenue, traffic flow typically improved on the approach to Cactus Road; average estimated speeds along this segment typically ranged from 30 to 50 mph.

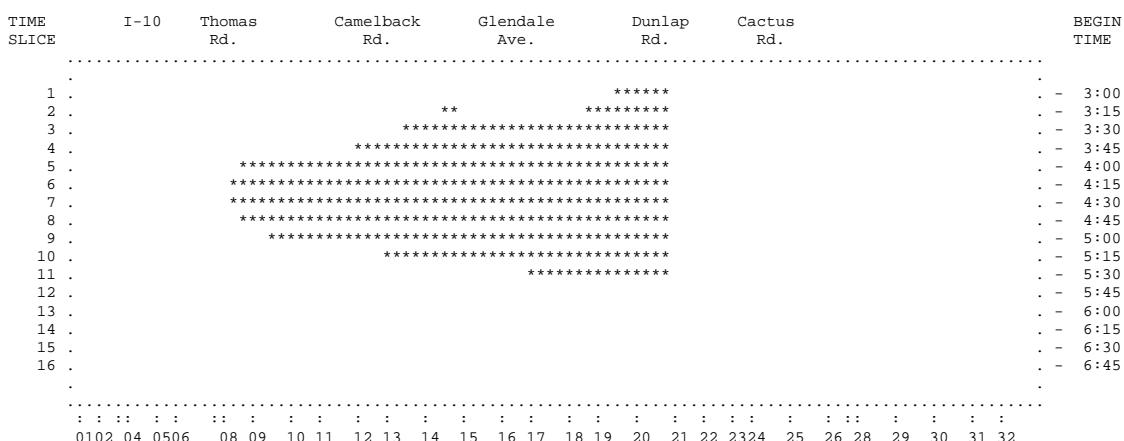
Density Data: Level of Service F (density greater than 45 vehicles per lane-mile) between Cactus Road and Dunlap Avenue between 4:00 and 6:00 pm; between Dunlap Avenue and Northern Avenue between 3:30 and 6:00 pm; between Northern Avenue and Bethany Home Road between 4:00 and 6:00 pm; between Bethany Home Road and Camelback Road between 3:30 and 6:00 pm; between Camelback Road and Indian School Road between 4:00 and 6:00 pm; and between Indian School Road and Thomas Road between 3:30 and 6:00 pm.

FREQ ANALYSIS

Segment J: I-17 NB; Van Buren Street to Bell Road; 3:00 to 7:00 pm

Existing Conditions: Bottlenecks occur at Peoria Avenue, Dunlap Avenue, and Bethany Home Road.

Queue Diagram of existing conditions for Segment J:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

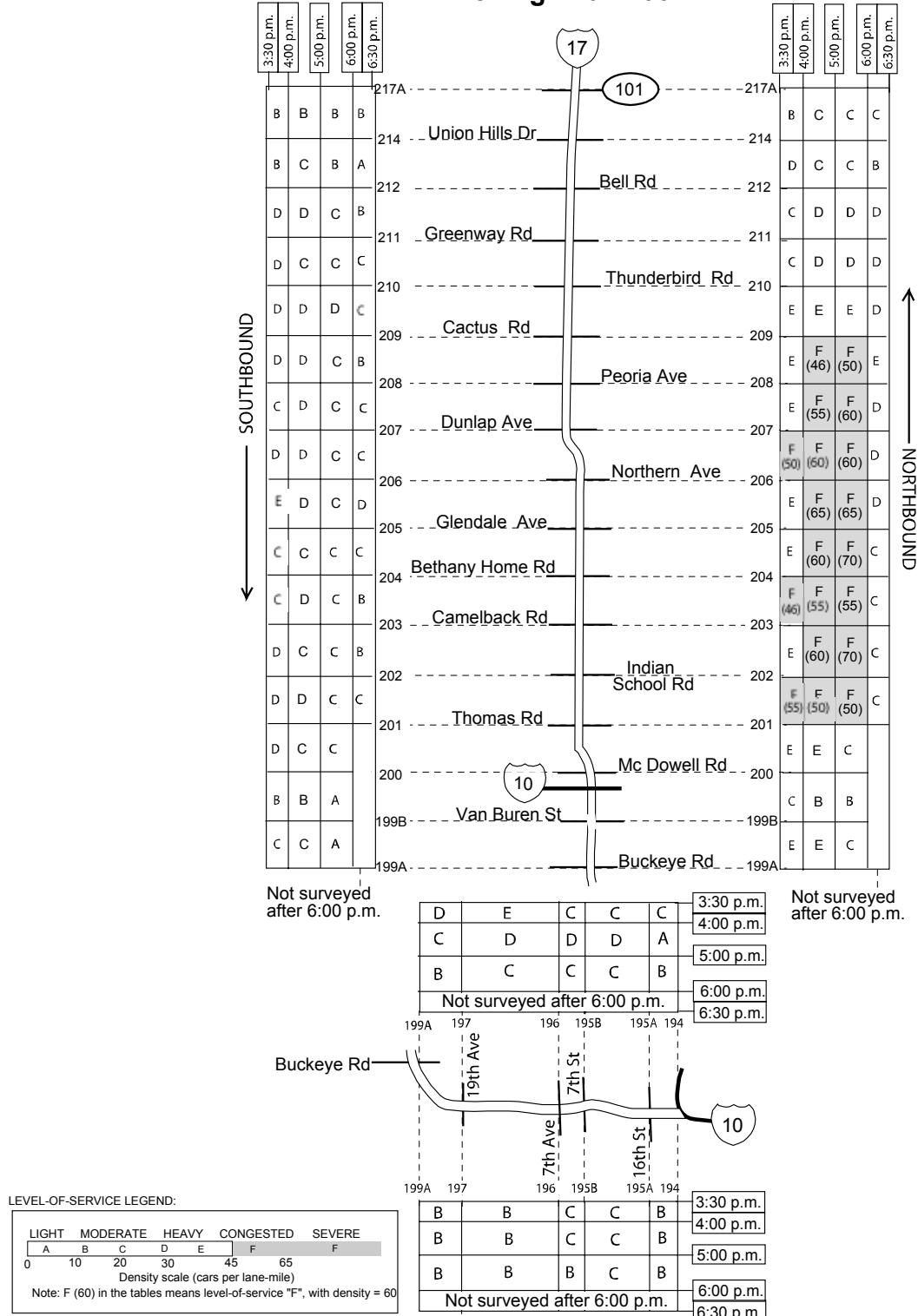
M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).



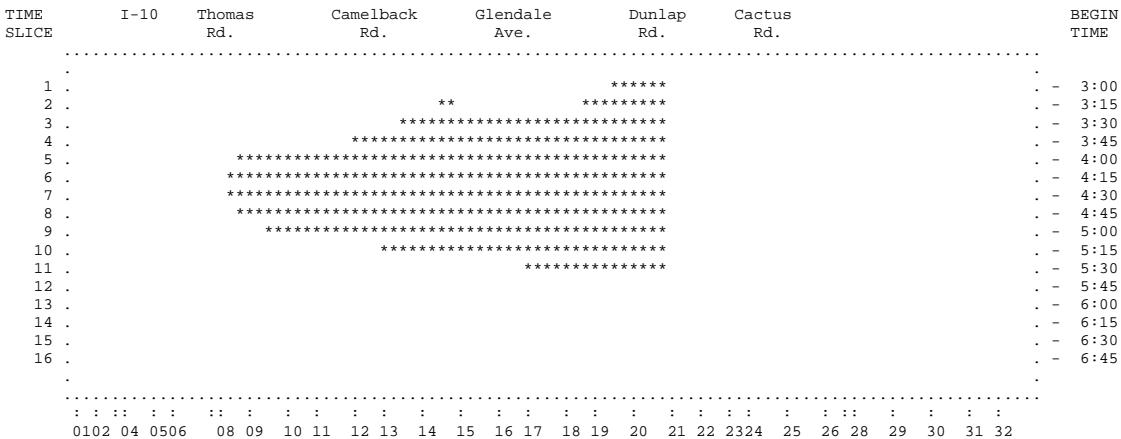
I-17
(Between Loop 101 & I-10)
Evening - Fall 2001



Alternative1: Add auxiliary lanes from Peoria Avenue to Greenway Road.

Result: This alternative has no impact on existing congestion.

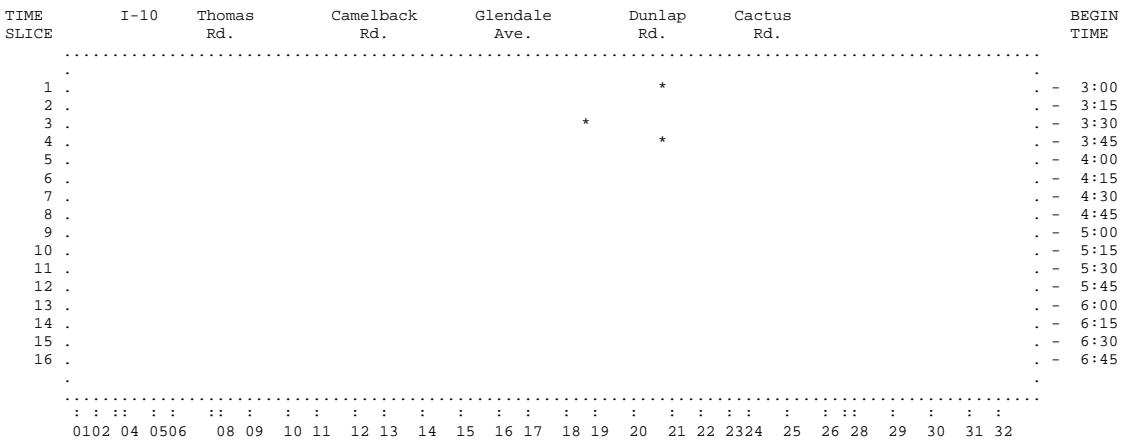
Queue Diagram of Alternative1 for Segment J:



Alternative2: Add ramp metering at 900 vehicles per hour throughout the entire segment.

Result: This alternative eliminates mainline congestion, however, it produces long queues and delay at on-ramps. Total freeway travel time increases nearly 45%.

Queue Diagram of Alternative 2 for Segment J:



ANALYSIS SUMMARY – SEGMENT J

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	6605	1292	7897	39.5
Alternative1	6598	1292	7890	39.5
Alternative2	3667	7779	11446	68.2

Conclusions/Recommendations:

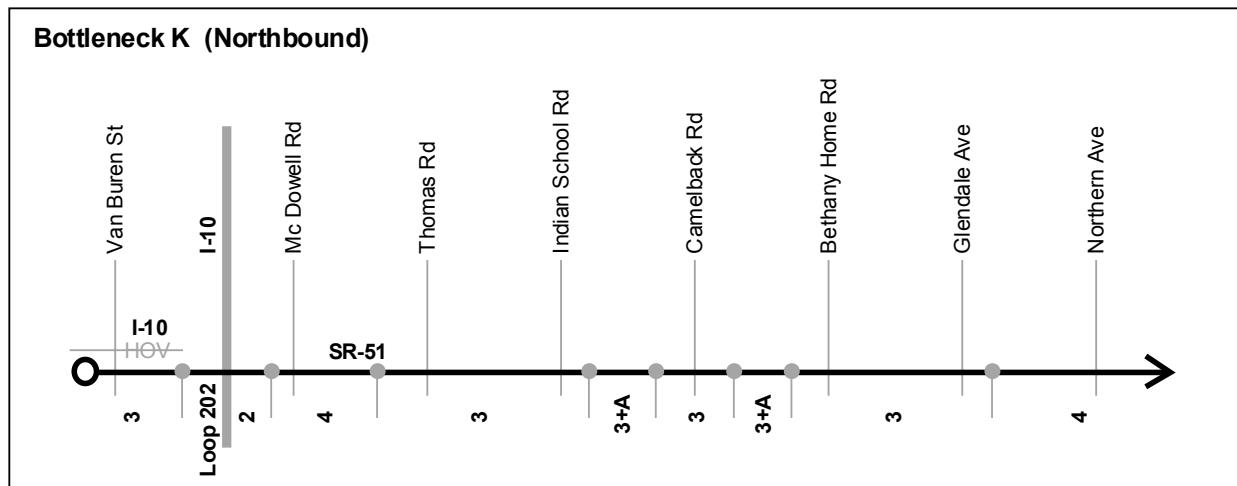
1. Short of adding a fourth general purpose lane, the addition of auxiliary lanes north of Peoria Avenue does not impact existing congestion.
2. Additional capacity along this section of the I-17 corridor could be achieved by elevating the existing HOV lanes on a structure. Space for light-rail could also be provided on the structure. The existing HOV lane could then be converted to a general purpose lane.

SEGMENT K
SR-51 NORTHBOUND: VAN BUREN STREET (ON I-10) TO NORTHERN AVENUE
EVENING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the K bottleneck segment. Lane numbers are shown below the black line. The letter "A" indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the K bottleneck segment reaches a maximum of 168,000 vehicles (vpd) near the intersection of SR-51 and McDowell Rd. The volume at this location during the PM peak hour is 13,500, which represents 8.0 percent of the total daily volume.

Northbound Traffic Volumes:

The volumes shown in the table below represent northbound counts along the K bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	PM Peak Hour Total Volume	PM Peak Hour GP Volume	PM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
I-10 / Van Buren St	7,300	6,800	500	8.7%	-----
SR-51 / Oak St	6,600	-----	-----	8.2%	-----
SR-51 / Camelback Rd	6,100	-----	-----	9.8%	-----
SR-51 / Northern Av	8,900	-----	-----	11.5%	-----

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	314	1.55	200	32	69	13
1999	287	1.40	170	36	67	14
2000	283	1.37	158	37	79	9
Total	884	1.44	528	105	215	36

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	314	245	69	0	7
1999	287	211	76	0	5
2000	283	211	72	0	4
Total	884	667	217	0	16

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During most observations, northbound congestion was found on SR-51 between I-10 and Indian School Road. The primary bottlenecks appeared to be the lane drop [4 lanes to 3] at Thomas Road, and vehicles entering at Indian School Road. Average speeds along this segment typically ranged from approximately 20 to 30 mph.

While congestion persisted North of Indian School Road, traffic flow generally improved in the approach to Glendale Avenue; average estimated speeds along this segment ranged from approximately 30 to 50 mph. Contributing to the improved flow was the widening of the roadway [3 lanes to 4] at the Glendale Avenue interchange.

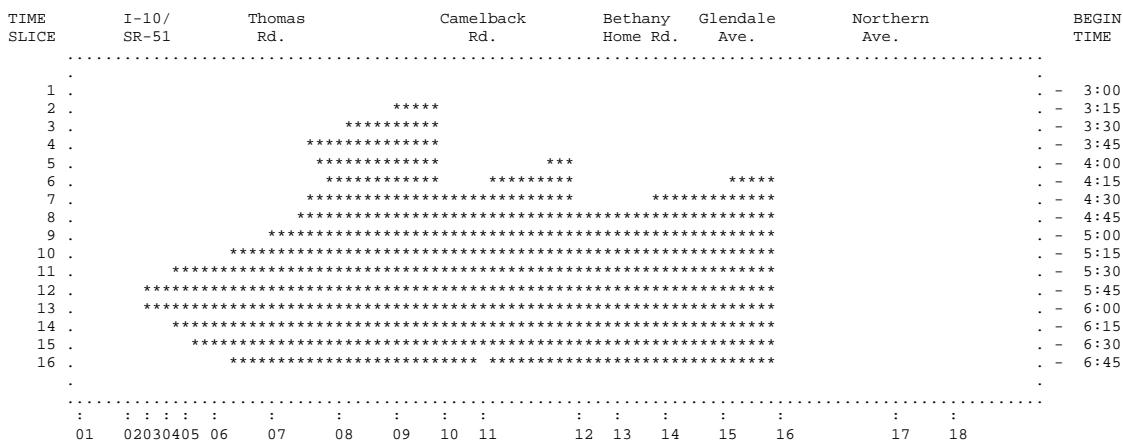
Density Data: LOS F (density greater than 45 vehicles per lane-mile) between Glendale Avenue and Bethany Home Road between 3:30 and 4:00 pm and again between 5:00 and 6:00 pm; between Bethany Home Road and Camelback Road between 5:00 and 6:00 pm; between Camelback Road and Indian School Road between 5:00 and 6:30 pm; between Indian School Road and Thomas Road between 4:00 and 6:30 pm; and between Thomas Road and McDowell Road between 4:00 and 6:00 pm.

FREQ ANALYSIS

Segment K: SR-51 NB; Van Buren Rd. to Northern Avenue; 3:00 to 7:00 pm

Existing Conditions: Bottlenecks exist at Indian School Rd, Camelback Rd, and Glendale Avenue. Congestion is partially a result of the roadway's horizontal and vertical geometry, which results in a lower free-flow speed and capacity.

Queue Diagram of Existing Conditions for Segment K:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

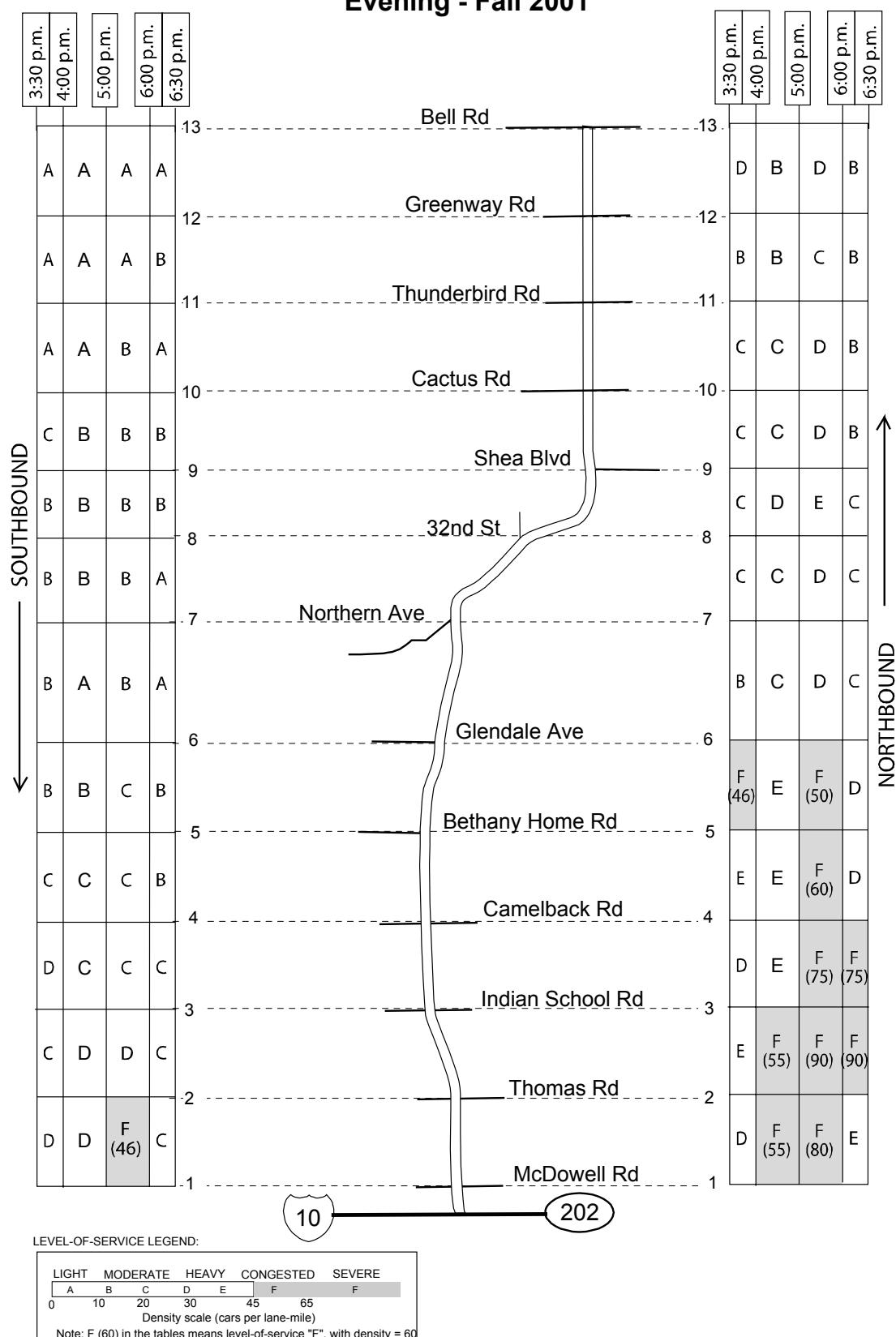
ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

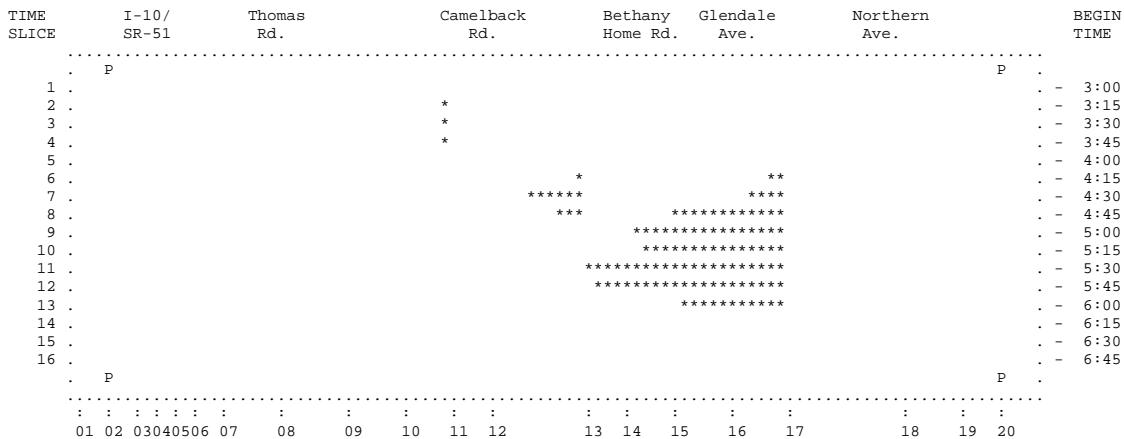
SR 51
Evening - Fall 2001



Alternative1: Add an HOV lane to this segment. For modeling purposes, it was assumed that 10% of the traffic contains 2 or 3+ passengers and thus can use the HOV lane.

Result: The model suggests that an HOV lane will result in a significant reduction in congestion. This may be an overstatement. Overall freeway travel time is projected to decrease 14%.

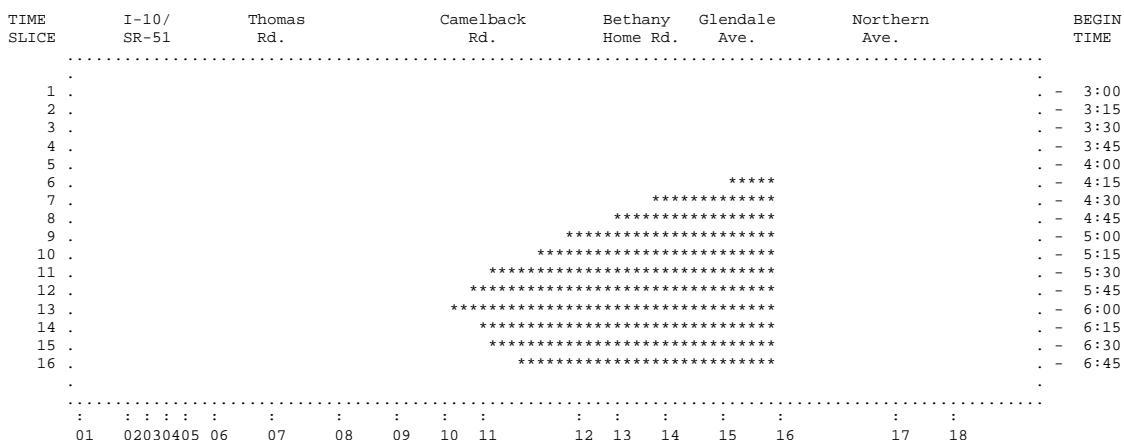
Queue Diagram of Alternative1 for Segment K:



Alternative2: Add a general purpose lane from McDowell Road to Glendale Avenue. Add an auxiliary lane from Glendale Avenue to Northern Avenue, with a two-lane on-ramp at Glendale Avenue. This alternative does not include an HOV lane.

Result: Eliminates all existing congestion. Overall freeway travel time decreases 16%.

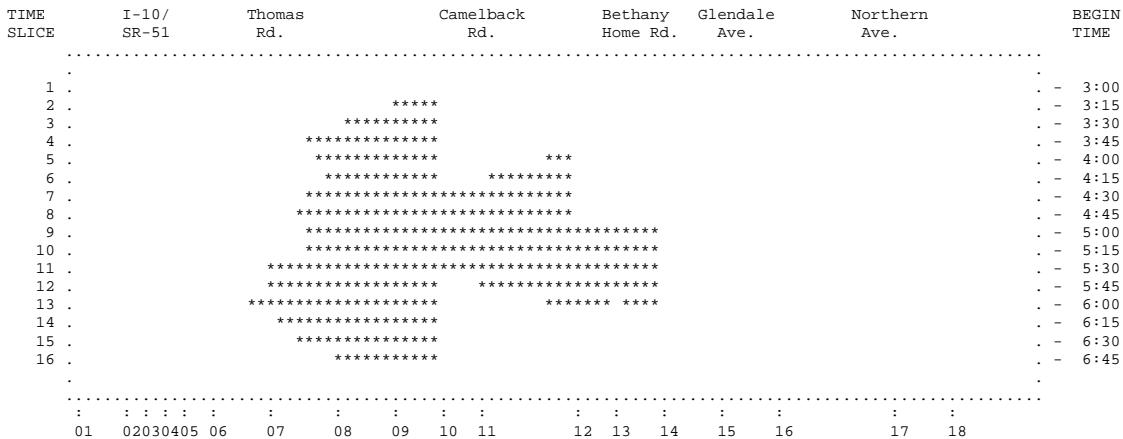
Queue Diagram of Alternative2 for Segment K:



Alternative3: Add an auxiliary lane from Glendale Avenue to Northern Avenue and a two-lane on-ramp at Glendale Avenue.

Result: Reduces congestion caused by the bottleneck at Glendale Avenue. The bottleneck at Indian School Road is not affected. Overall freeway travel time decreases 10%.

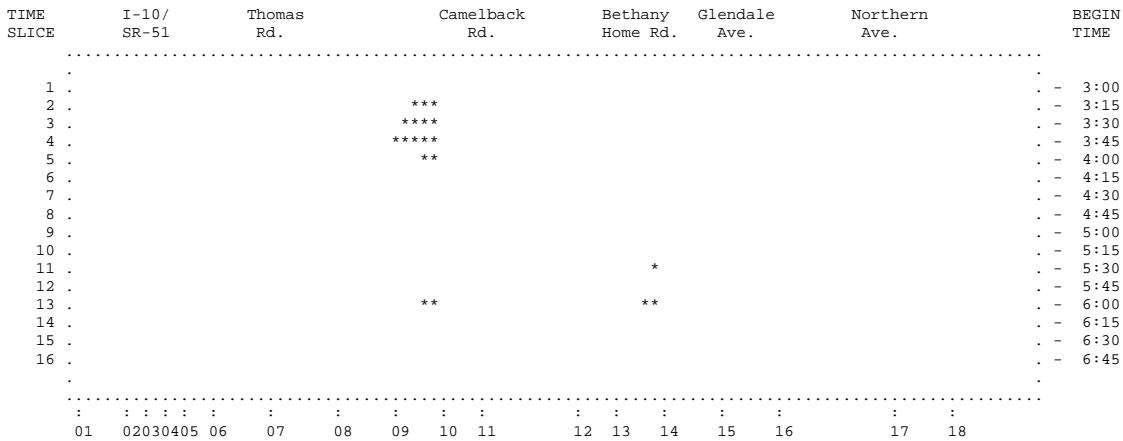
Queue Diagram of Alternative3 for Segment K:



Alternative4: Add ramp metering at 900 vehicles per hour throughout the segment.

Result: Greatly reduces mainline congestion, but produces significant queuing on some of the on-ramps. Overall freeway travel time increases 15%.

Queue Diagram of Alternative4 for Segment K:



ANALYSIS SUMMARY – SEGMENT K

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	6801	15572	22372	30.9
Alternative1	3477	15797	19274	56.0
Alternative2	5687	15572	21239	37.7
Alternative3	5297	14619	19916	40.7
Alternative4	3246	22597	25843	63.2

Conclusions/Recommendations:

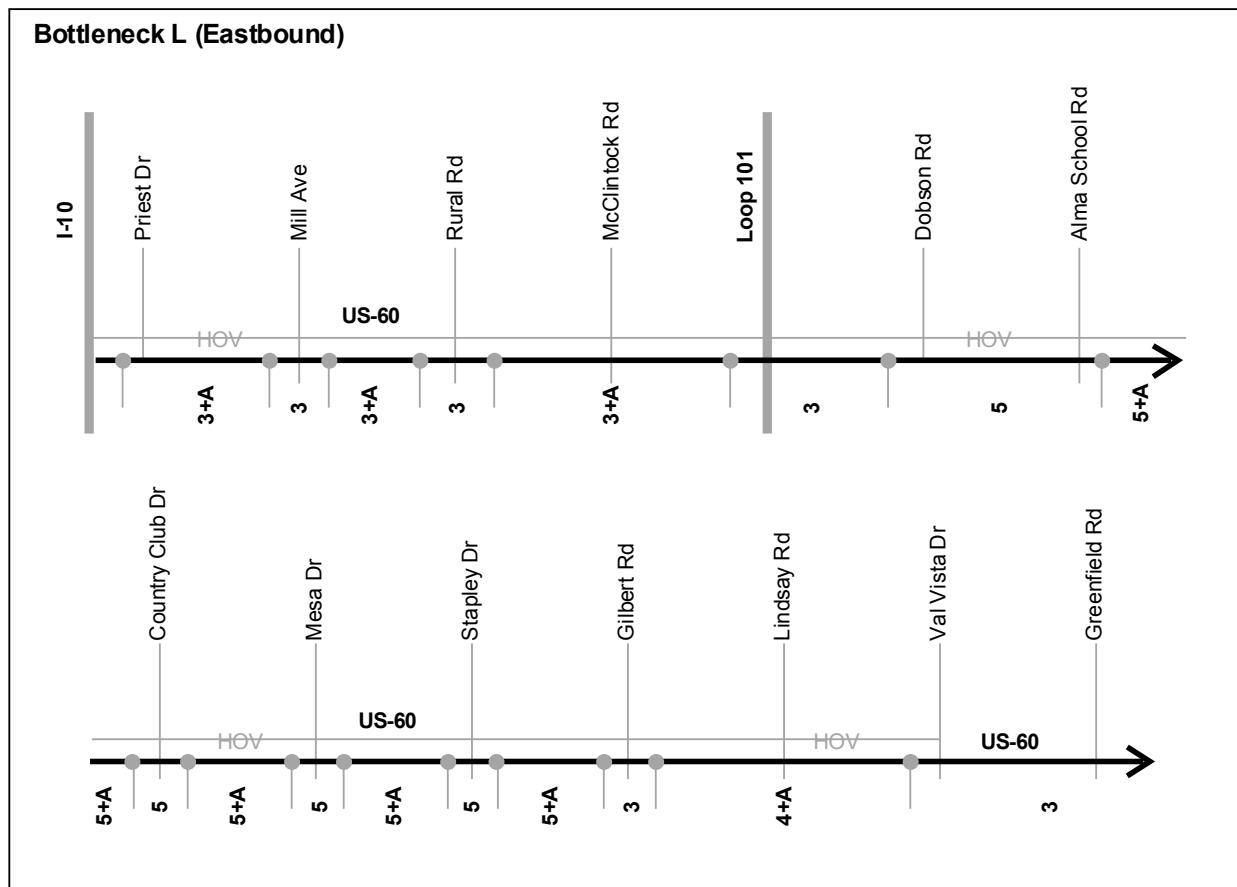
1. Adding the planned HOV lane will improve existing traffic flow on this section of SR-51, however, probably not to the degree predicted by the freeway model in this analysis.
2. Widening the freeway to a 4+A cross-section from McDowell Road to Glendale Avenue and adding an auxiliary lane from Glendale Avenue to Northern Avenue will significantly reduce congestion. The addition of just the auxiliary lane from Glendale Avenue to Northern Avenue, including a two-lane on-ramp at Glendale Avenue will provide appreciable benefit to traffic flow.
3. Stricter ramp metering can improve traffic flow on the mainline, however, additional storage will be required at each on-ramp.

SEGMENT L
US-60 EASTBOUND: I-10 TO GREENFIELD ROAD
EVENING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the L bottleneck segment. Lane numbers are shown below the black line. The letter "A" indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the L bottleneck segment reaches a maximum of 176,000 vehicles (vpd) near the intersection of US-60 and Mesa Dr. The volume at this location during the PM peak hour is 11,600, which represents 6.6% of the total daily volume.

Eastbound Traffic Volumes:

The volumes shown in the table below represent eastbound counts along the L bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	PM Peak Hour Total Volume	PM Peak Hour GP Volume	PM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
US-60 / Priest Dr	6,200	-----	-----	7.7%	0.5%
US-60 / Mesa Dr	6,100	-----	-----	7.0%	1.2%
US-60 / Gilbert Rd	5,700	-----	-----	7.8%	-----
US-60 / Greenfield Rd	5,300	-----	-----	7.0%	-----

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	684	2.11	452	76	134	22
1999	754	2.28	508	108	107	31
2000	641	1.90	450	87	85	19
Total	2079	2.10	410	271	326	72

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	684	477	206	1	24
1999	754	554	200	0	32
2000	641	455	184	2	26
Total	2079	1486	590	3	82

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During the peak period, eastbound congestion was found on US-60 from the vicinity of I-10 to McClintock Drive; average estimated speeds along this segment typically ranged from approximately 10 to 30 mph. Ongoing construction (right shoulder closed) between I-10 and McClintock Drive may have exacerbated the congestion.

During the peak period, eastbound congestion was found on US-60 between Loop 101 and Country Club Drive. Ongoing construction (right shoulder closed) between Dobson Road and Val Vista Drive may have exacerbated the congestion. Average speeds along this segment typically ranged from approximately 15 to 25 mph.

While congestion persisted east of Country Club Drive, traffic flow typically improved in the approach to Lindsay Road; average estimated speeds along the corridor typically ranged from approximately 35 to 45 mph.

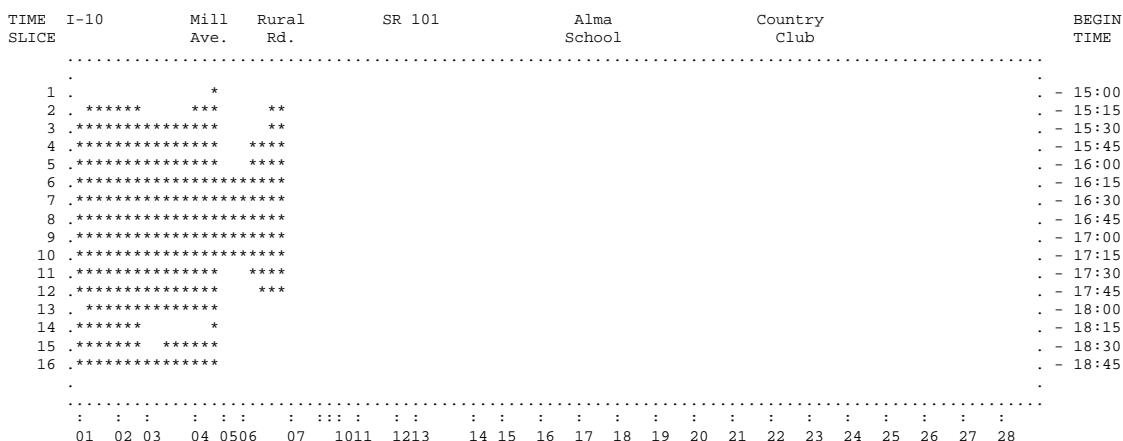
Density Data: Level of Service F (density greater than 45 vehicles per lane-mile) westbound between Mesa Drive and Stapely Drive between 3:00 and 4:00 pm. Level of Service F eastbound between I-10 and Priest Drive between 5:00 and 6:00 pm; between Preist Drive and McClintock Drive between 3:30 and 6:30 pm; between Loop 101 and Dobson Road between 3:30 and 4:00, and again between 6:00 and 6:30 pm; between Dobson Road and Country Club Drive between 3:30 and 6:30 pm; between Country Club Drive and Mesa Drive between 4:00 and 6:30 pm; and between Mesa Drive and Lindsay Road between 5:00 and 6:00 pm.

FREQ ANALYSIS

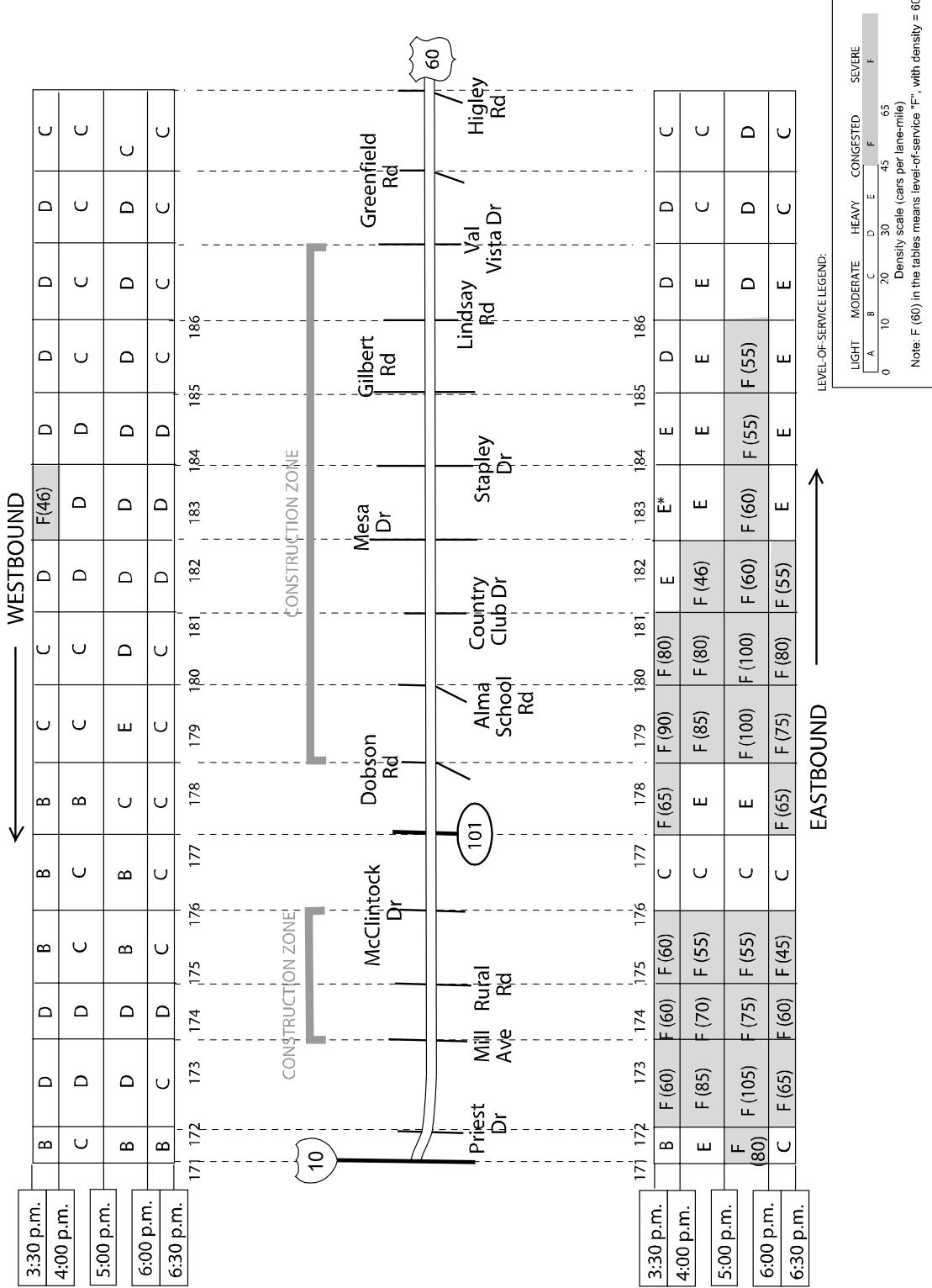
Segment L: US-60 EB; I-10 to Greenfield Road; 3:00 to 7:00 pm

Existing Conditions: Bottlenecks currently occur at Mill Avenue and Rural Road. Since traffic data for this freeway segment was collected during construction, it was not possible to develop an accurate model of existing conditions. The existing conditions model developed for this segment includes the new freeway geometry and lane configuration that is under construction. This includes a cross-section of 3+1 within the City of Tempe and 5+1+A from the Loop 101 interchange to Power Road.

Queue Diagram of Existing Conditions for Segment L:



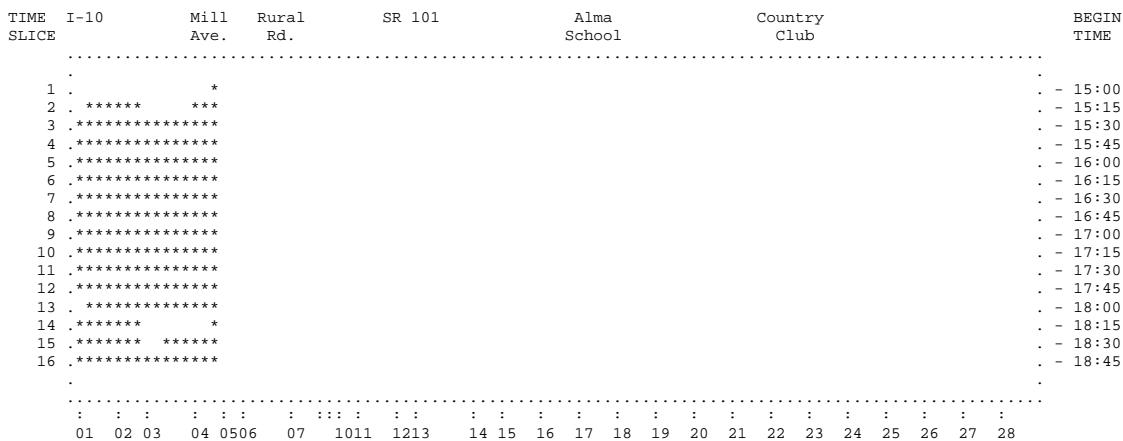
**US Route 60
(Between I-10 & Higley Rd)
Evening - Fall 2001**



Alternative1: Add auxiliary lanes from I-10 to Loop 101. These additions are going to be included in the current construction.

Result: This alternative eliminates the Rural Road bottleneck, however, the bottleneck at Mill Avenue remains. Overall freeway travel time decreases 4%.

Queue Diagram of Alternative1 for Segment L:



ANALYSIS SUMMARY – SEGEMENT L

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	6696	2019	8714	48.6
Alternative1	6418	2006	8424	50.8

Conclusions/Recommendations:

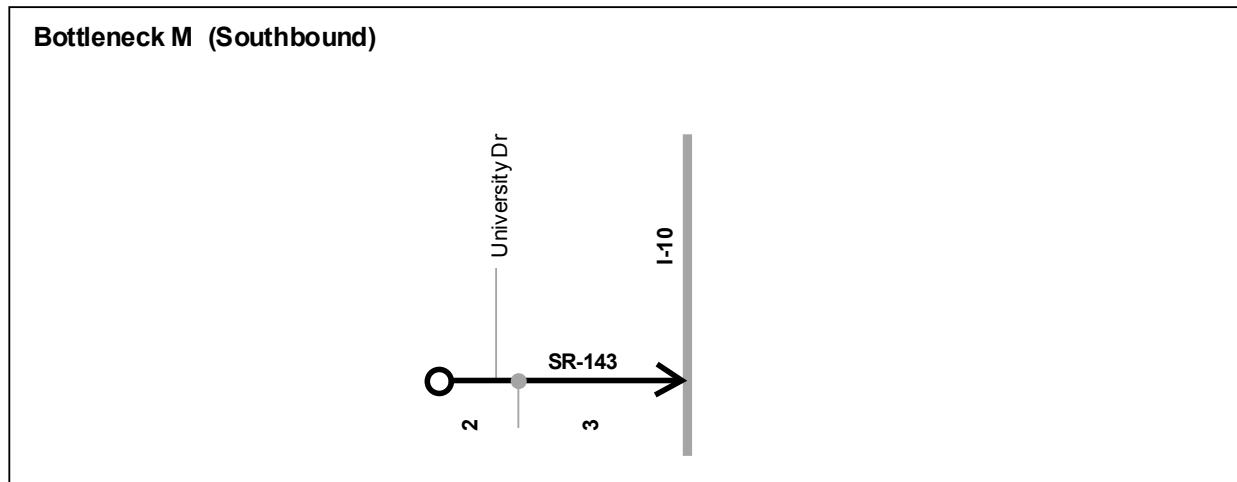
Although an accurate model of existing conditions on this freeway section could not be developed, the evaluation of conditions with the on-going construction project complete, including auxiliary lanes from I-10 to Loop 101, indicates that the bottleneck at Mill Avenue will create congestion that will likely back onto the northbound to eastbound I-10 to US-60 connector-ramp. Additional through lane capacity is needed on the section of US-60 from I-10 to Loop 101.

SEGMENT M
SR-143 SOUTHBOUND: UNIVERSITY DRIVE TO I-10
EVENING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the M bottleneck segment. Lane numbers are shown below the black line. The letter "A" indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the M bottleneck segment reaches a maximum of 69,000 vehicles (vpd) at the intersection of SR-143 and University Dr. The volume at this location during the PM peak hour is 5,400, which represents 7.8% of the total daily volume.

Southbound Traffic Volumes:

The volumes shown in the table below represent southbound counts along the M bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	PM Peak Hour Total Volume	PM Peak Hour GP Volume	PM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
SR-143 / University Dr	2,700	-----	-----	7.9%	-----

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	26	2.00	22	5	0	0
1999	21	1.61	16	3	2	0
2000	18	1.38	17	0	0	1
Total	65	1.66	55	7	2	1

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	26	23	3	0	0
1999	21	18	3	0	0
2000	18	10	8	0	0
Total	65	51	14	0	0

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During the peak period, congestion was typically found on the southbound on-ramp at University Drive; when congested, queue populations at the ramp meter ranged from approximately 80 to 90 vehicles (one thru-lane at the ramp meter).

During the peak period, congestion was typically found on the off-ramp to I-10 (eastbound); at its maximum observed extent, the queue extended back into the right lane of SR-143.

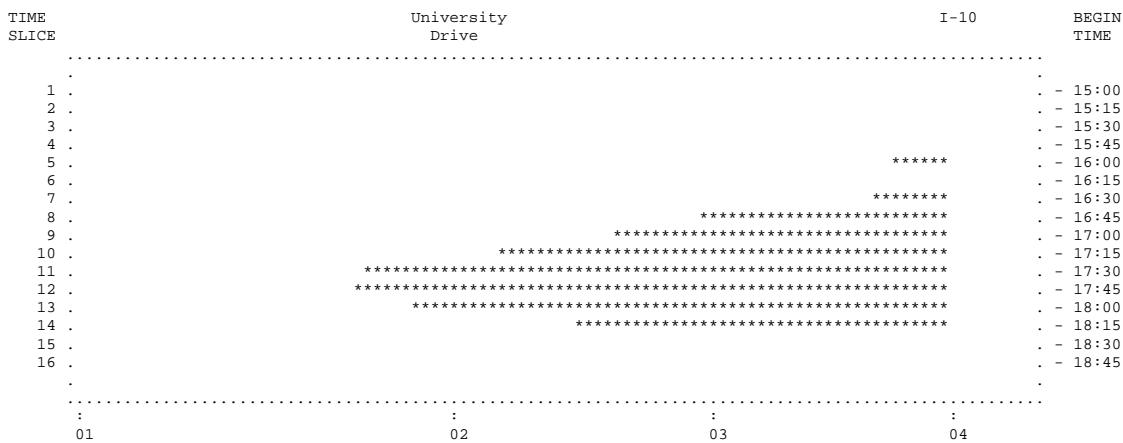
Density Data: Level of Service F (density greater than 45 vehicles per lane-mile) between University Drive and I-10 between 5:00 and 6:00 pm.

FREQ ANALYSIS

Segment M: SR-143 SB; University Dr. to I-10; 3:00 to 7:00 pm

Existing Conditions: The bottleneck at the I-10/SR-143 interchange is caused by congestion on the right-side loop ramp and the traffic signal at the Broadway Road on-ramp to I-10.

Queue Diagram of existing conditions for Segment M:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

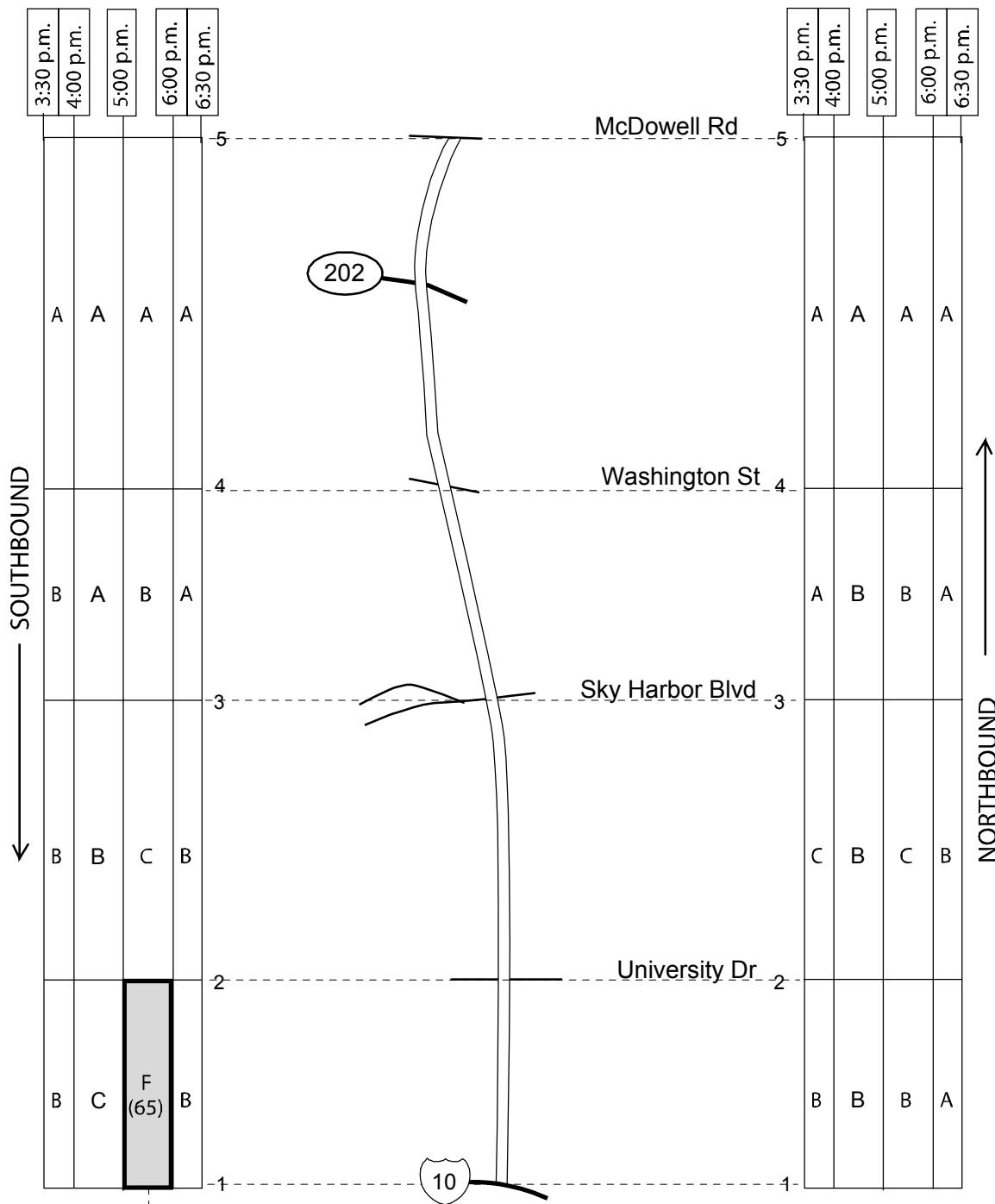
ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

SR 143
Evening - Fall 2001



These level-of-service ratings represent the mathematical average of densities, which varied widely between the right- and left-hand lanes. When congested, densities in the right lane approaching I-10 were as high as 80 pcplpm with corresponding speed estimates of 20 to 25 mph.

LEVEL-OF-SERVICE LEGEND:

LIGHT	MODERATE	HEAVY	CONGESTED	SEVERE
A 0	B 10	C 20	D 30	E 45

Density scale (cars per lane-mile)

Note: F (60) in the tables means level-of-service "F", with density = 60

Conclusions/Recommendations:

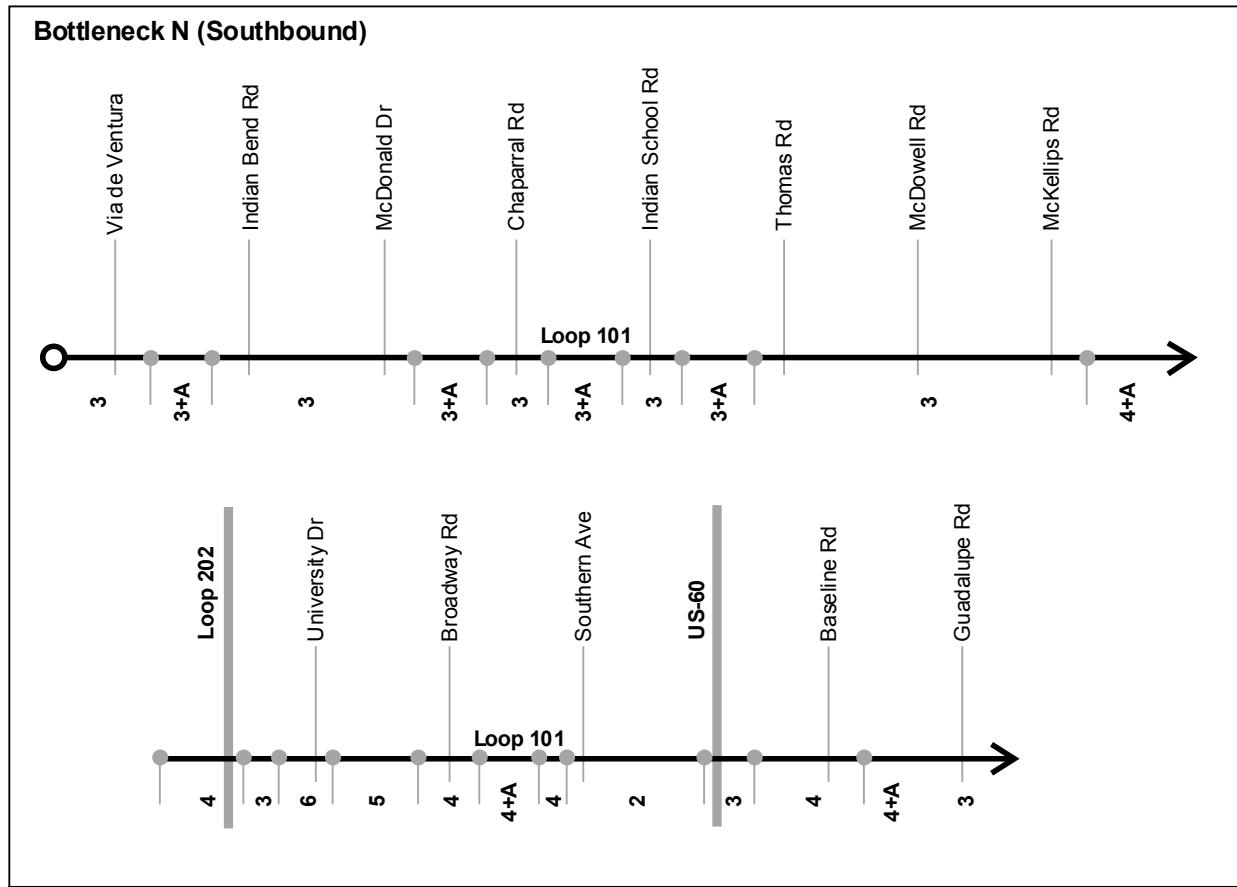
1. The planned collector-distributor road on this section of I-10 will eliminate the direct ramp connections between SR-143 and I-10. Instead, SR-143 will connect to the collector-distributor road and traffic destined for I-10 will enter the freeway at Baseline Road. A detailed evaluation of the impacts of the collector-distributor road on SR-143 traffic operations is needed.

SEGMENT N
LOOP 101 SOUTHBOUND: VIA DE VENTURA TO GUADALUPE ROAD
EVENING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the N bottleneck segment. Lane numbers are shown below the black line. The letter "A" indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the N bottleneck segment reaches a maximum of 192,000 vehicles (vpd) near the intersection of Loop 101 and Southern Ave. The volume at this location during the PM peak hour is 14,000, which represents 7.3% of the total daily volume.

Southbound Traffic Volumes:

The volumes shown in the table below represent southbound counts along the N bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	PM Peak Hour Total Volume	PM Peak Hour GP Volume	PM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
Loop 101 / McDonald Dr	4,000	-----	-----	8.2%	-----
Loop 101 / Indian School Rd	5,700	-----	-----	8.1%	-----
Loop 101 / Thomas Rd	7,000	-----	-----	8.2%	-----
Loop 101 / McKellips Rd	6,800	-----	-----	7.5%	-----
Loop 101 / 8 th St	8,100	-----	-----	6.9%	-----
Loop 101 / Southern Ave	7,700	-----	-----	6.4%	0.4%

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	83	0.42	51	6	21	5
1999	124	0.46	57	18	31	18
2000	276	0.82	137	51	71	17
Total	483	0.57	245	75	123	40

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	83	66	16	1	1
1999	124	85	37	2	6
2000	276	198	76	1	7
Total	483	348	130	4	14

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During the peak period, an extended zone of southbound congestion was found on Loop 101 between Via de Ventura (five miles north of Thomas Road) and McDowell Road. Congestion appeared to be caused or exacerbated by weaving and merging associated with the interchanges along this corridor. Average estimated speeds ranged widely, from approximately 15 to 45 mph.

While congestion persisted south of McDowell Road, traffic flow typically improved on the approach to McKellips Road; average estimated speeds along this segment ranged from approximately 35 to 50 mph. Contributing to the improved flow was the widening of the roadway (3 lanes to 4) at McKellips Road.

During the peak period, southbound congestion was found on Loop 101 between Loop 202 and US- 60; average estimated speeds along this segment typically ranged from approximately 30 to 45 mph. Factors contributing to the congestion were 1) the lane drop [5 lanes to 4] at Broadway Road and 2) the lane drop [4 lanes to 2] at the US-60 interchange.

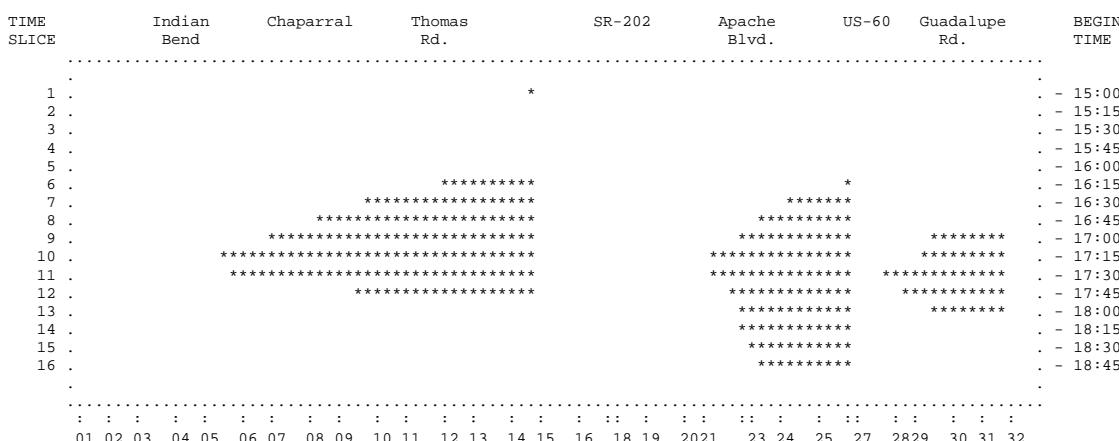
Density Data: Level of Service F (density greater than 45 vehicles per lane-mile) southbound between McDowell Road and McKellips Road between 3:30 and 6:00 pm; between University Drive and Southern Avenue between 5:00 and 6:30 pm; and between Southern Avenue and the US-60 interchange between 4:00 and 6:30 pm.

FREQ ANALYSIS

Segment N: Loop 101 SB; Via de Ventura to Guadalupe Rd; 3:00 to 7:00 pm

Existing Conditions: Existing bottlenecks occur at McDowell Road, the US-60 interchange, and Guadalupe Road.

Queue Diagram of Existing Conditions for Segment N:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

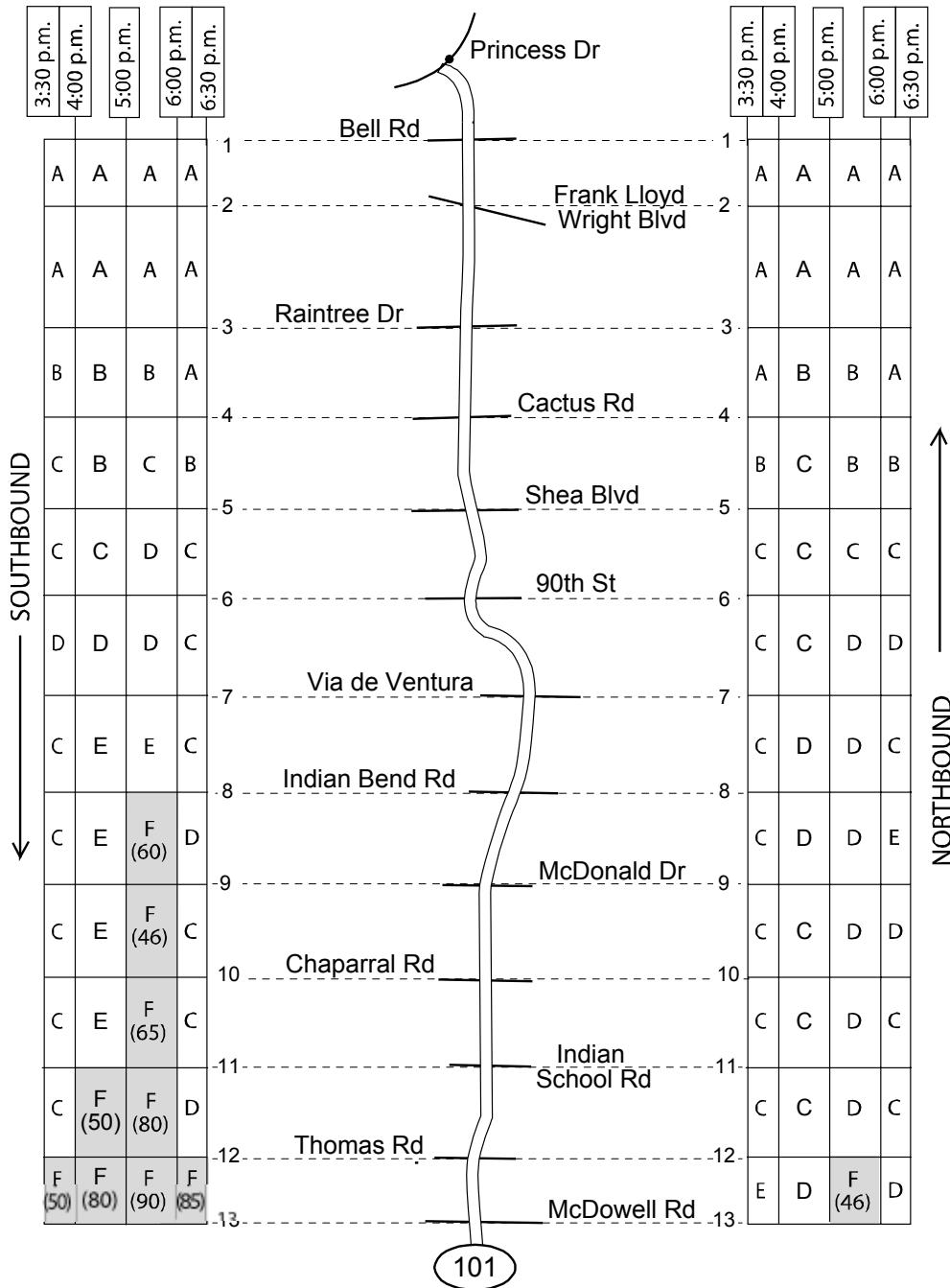
M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).



Loop 101-Pima Freeway
(Between Princess Dr & McDowell Rd)
Evening - Fall 2001

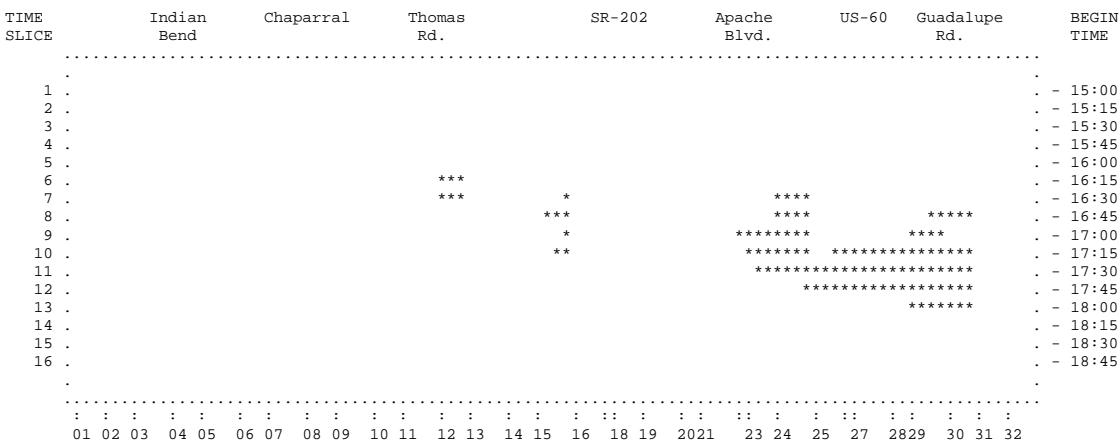


LEVEL-OF-SERVICE LEGEND:					
LIGHT	MODERATE	HEAVY	CONGESTED	SEVERE	
A	B	C	D	E	F
Density scale (cars per lane-mile)					
0	10	20	30	45	65
Note: F (60) in the tables means level-of-service "F", with density = 60					

Alternative1: Add auxiliary lanes from Thomas Road to McKellips Road and include a third through lane across the US-60 interchange.

Result: This alternative significantly reduced congestion at the McDowell Road bottleneck. Adding the third lane through the US-60 interchange reduced the congestion somewhat. Overall, freeway travel time decreases 26%.

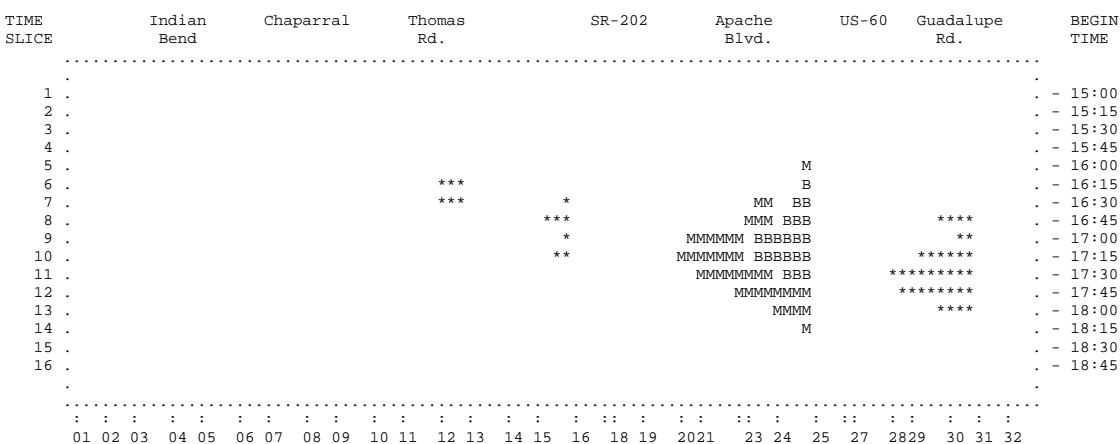
Queue Diagram of Alternative1 for Segment N:



Alternative2: Add a fifth general purpose lane from the Loop 202 on ramp to the US-60 off-ramp with a mandatory two-lane exit at US-60.

Result: This significantly reduced congestion at the McDowell Road bottleneck, but creates a merging problem at the US-60 interchange. Overall, freeway travel time decreases 26%.

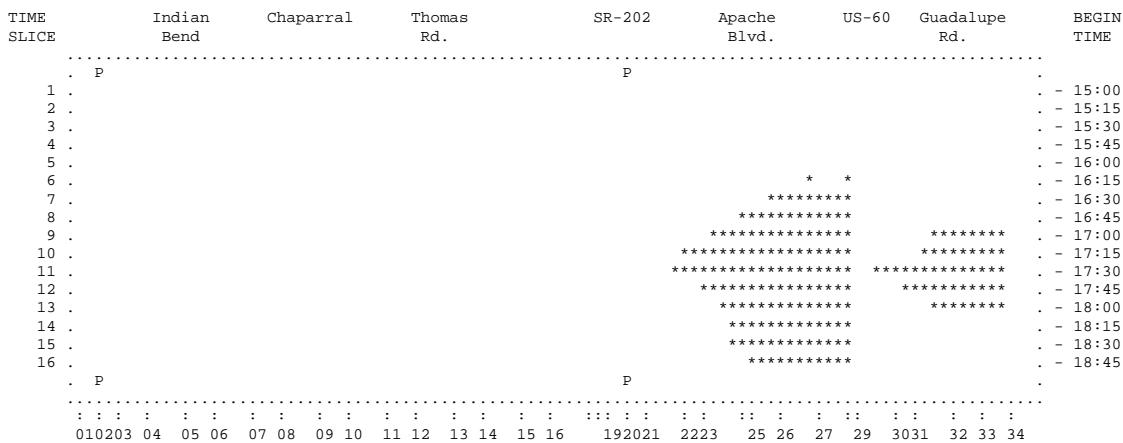
Queue Diagram of Alternative2 for Segment N:



Alternative3: Add an HOV lane to this segment. For modeling purposes it was assumed that 10% of the traffic contains 2 or 3+ passengers and thus can use the HOV lane. This does not include the addition of any other physical improvements.

Result: This alternative eliminates congestion at the McDowell Road bottleneck, however, does not improve conditions downstream. Overall, freeway travel time decreases 15%.

Queue Diagram of Alternative3 for Segment N:



ANALYSIS SUMMARY – SEGMENT N

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	7255	0	7255	41.3
Alternative1	5352	0	5352	56.5
Alternative2	5138	267	5405	58.7
Alternative3	6200	0	6200	43.1

Conclusions/Recommendations:

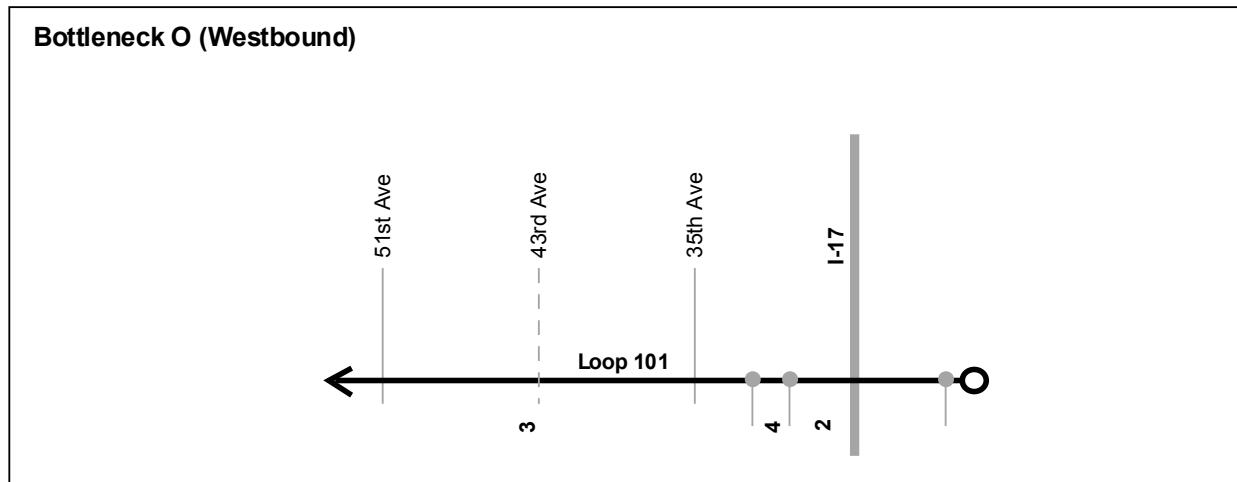
- Adding auxiliary lanes from Thomas Road to McKellips Road and a third general-purpose lane through the US-60 interchange will significantly reduce congestion. A four-lane cross section will be required east of Guadalupe Road
- An HOV lane may benefit traffic flow within this freeway section, however, the level of improvement will depend upon the amount of traffic entering or exiting the HOV lane within the freeway section between Loop 202 and US-60. Significant weaving associated with the HOV lane will impact overall mainline flow.

SEGMENT O
LOOP 101 WESTBOUND: I-17 TO 51ST AVENUE
EVENING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the O bottleneck segment. Lane numbers are shown below the black line. The letter "A" indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along the O bottleneck segment reaches a maximum of 124,000 vehicles (vpd) near the intersection of Loop 101 and 43rd Ave. The volume at this location during the PM peak hour is 10,400, which represents 8.4% of the total daily volume.

Westbound Traffic Volumes:

The volumes shown in the table below represent westbound counts along the O bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	PM Peak Hour Total Volume	PM Peak Hour GP Volume	PM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
Loop 101 / 35 th Av	6,500	-----	-----	10.2%	-----

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	8	0.20	3	1	4	0
1999	30	0.61	4	6	12	8
2000	32	0.55	10	4	16	2
Total	70	.045	17	11	32	10

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	8	6	2	0	0
1999	30	22	8	0	4
2000	32	24	8	0	1
Total	70	52	18	0	5

SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

Observations: During most observations, westbound congestion was typically found on Loop 101 (Agua Fria Freeway) between I-17 and 51st Avenue; average estimated speeds typically ranged from approximately 30 to 50 mph. Congestion appeared to be caused or exacerbated by weaving and merging associated with the interchanges along the corridor.

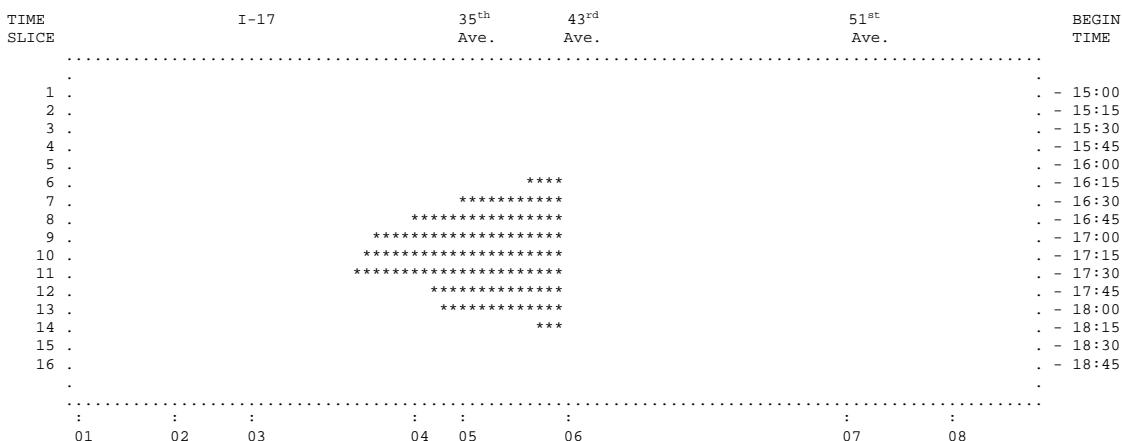
Density Data: Level of Service F (density greater than 45 vehicles per lane-mile) westbound between 43rd Avenue and 35th Avenue between 4:00 and 6:30 pm.

FREQ ANALYSIS

Segment O: *Loop 101 WB; I-17 to 51st Avenue; 3:00 to 7:00 pm*

Existing Conditions: An existing bottleneck occurs at 43rd Avenue as a result of the heavy traffic volumes from I-17 and 35th Avenue.

Queue Diagram of Existing Conditions for Segment O:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

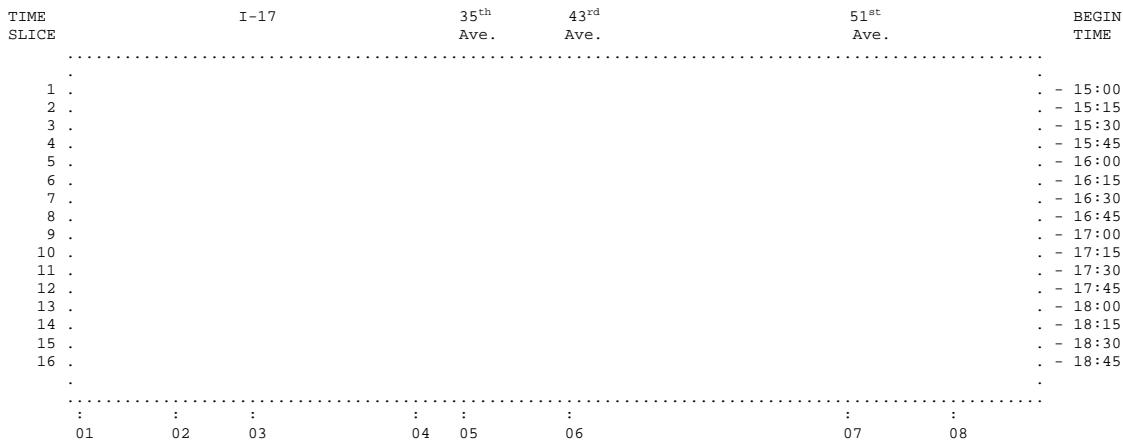
B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

Alternative1: Add a general purpose lane from the I-17 on ramp to the 51st Avenue off-ramp making a four-lane cross-section from 35th Avenue to 51st Avenue.

Result: This alternative eliminates congestion within this segment. Overall freeway travel time decreases 10%.

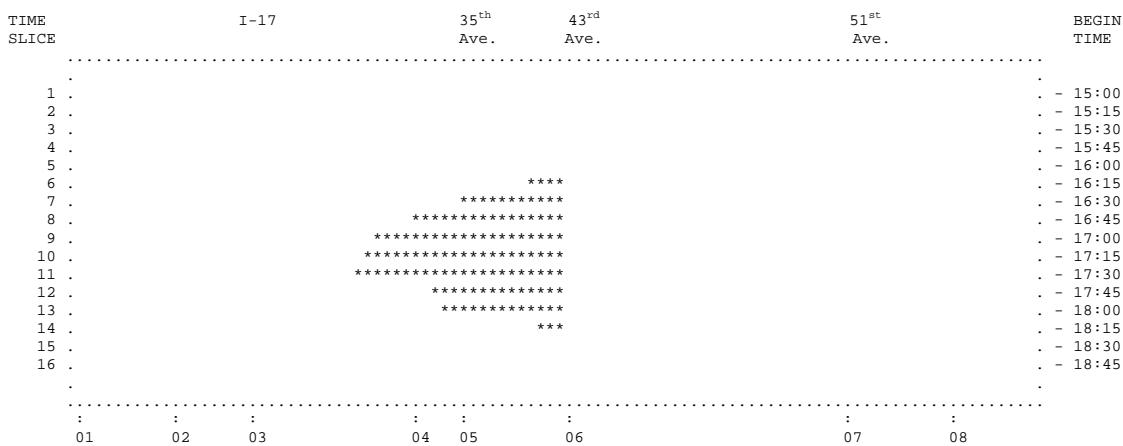
Queue Diagram of Alternative1 for Segment O:



Alternative2: Add dual ramp metering at 35th Avenue allowing 1,600 vehicles per hour.

Result: At a 1,600 vehicles per hour metering rate, this alternative does not affect the mainline bottleneck delays.

Queue Diagram of Alternative2 for segment O:



ANALYSIS SUMMARY – SEGMENT O

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	2077	3610	5687	50.7
Alternative1	1562	3610	5172	67.4
Alternative2	2077	3610	5687	50.7

Conclusions/Recommendations:

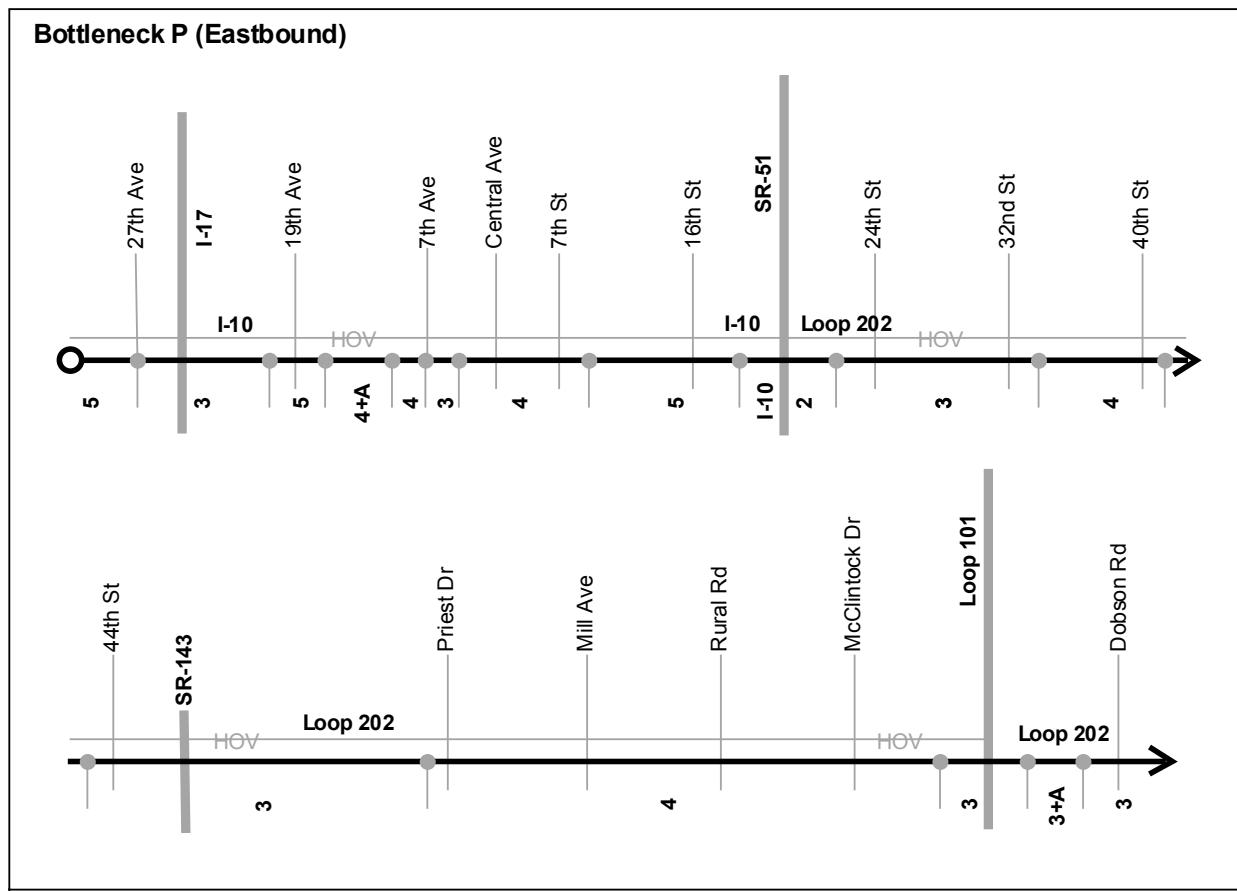
1. On this section of Loop 101, a fourth general purpose lane is needed from 35th Avenue to 51st Avenue.
2. Implementation of dual lane ramp metering at 35th Avenue will have little impact on the existing level of mainline congestion.

SEGMENT P
LOOP 202 EASTBOUND: 27TH AVENUE (ON I-10) TO DOBSON ROAD
EVENING PEAK PERIOD

EXISTING CONDITIONS

Geometrics:

The following schematic illustrates the lane configuration along the P bottleneck segment. Lane numbers are shown below the black line. The letter "A" indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



Daily Traffic Volume, Both Directions:

Daily traffic volume along this bottleneck segment reaches a maximum of 259,000 vehicles (vpd) at the intersection of I-10 and 7th St. The volume at this location during the PM peak hour is 16,200 for General Purpose lanes and 3,000 for HOV lanes. These combined peak hour volumes represent 7.4% of the total daily volume.

Eastbound Traffic Volumes:

The volumes shown in the table below represent eastbound counts along the P bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

TRAFFIC VOLUMES

Location	PM Peak Hour Total Volume	PM Peak Hour GP Volume	PM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
I-10 / 31 st Av	7,300	6,700	600	6.5%	3.9%
I-10 / 7 th Av	8,300	7,500	800	6.6%	-----
I-10 / 16 th St	9,500	8,100	1,400	7.8%	2.3%
Loop 202 / 32 nd St	7,600	6,500	1,100	7.3%	0.5%
Loop 202 / Mill Av	9,200	8,100	1,100	8.5%	0.6%
Loop 202 / Dobson Rd	5,600	-----	-----	12.2%	-----

CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	873	1.57	568	128	137	40
1999	995	1.70	648	161	146	40
2000	1099	1.80	736	200	125	38
Total	2967	1.69	1952	489	408	118

CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	873	638	233	2	32
1999	995	699	295	1	49
2000	1099	757	341	1	47
Total	2967	2094	869	4	128



SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following two pages.

Observations: During the peak period, eastbound congestion was typically found in the freeway ramp from I-10 to Loop 202; this congestion appeared to be caused or exacerbated by weaving east of the SR-51/Loop 202/ I-10 interchange.

On one day only, a short zone of eastbound congestion was found on Loop 202 between I-10/SR-51 and 24th Street; traffic entering at 24th Street appeared to cause or exacerbate the congestion.

During most observations, eastbound congestion was found on Loop 202 between SR-143 and Loop 101 (Pima Freeway); vehicles merging into the two right lanes to exit at Loop 101 appeared to cause or exacerbate the congestion. West of McClintock Drive, the congestion extended across all four lanes. During the peak period, average estimated speeds along this segment typically ranged from approximately 20 to 30 mph.

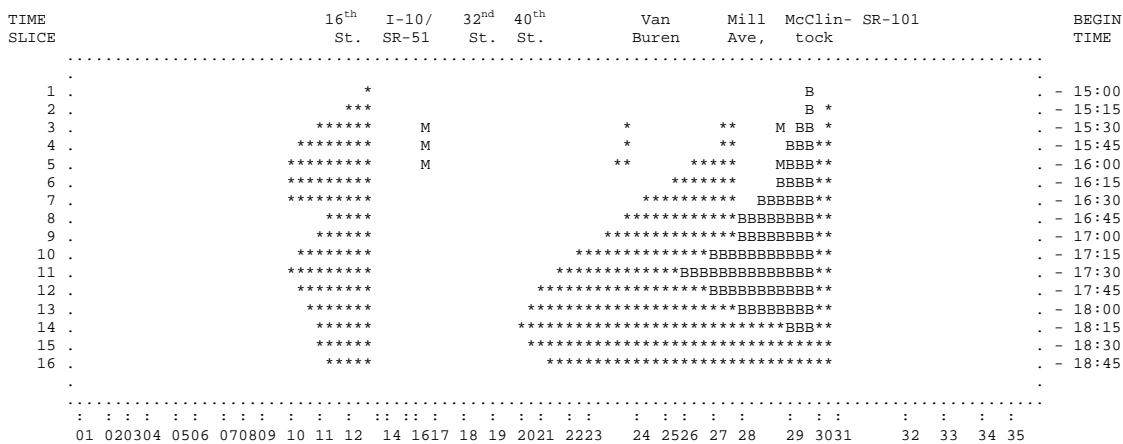
Density Data: Level of Service F (density greater than 45 vehicles per lane-mile) westbound between 24th Street and 32nd Street between 3:30 and 4:00 pm and again between 5:00 and 6:00 pm; Level of Service F eastbound between Van Buren Street and 56th Street between 5:00 and 6:30 pm; between 56th Street and McClintock Drive between 3:20 and 6:30 pm.

FREQ ANALYSIS

Segment P: Loop 202 EB; 27th Avenue to Dobson Rd; 3:00 to 7:00 pm

Existing Conditions: Existing bottlenecks occur at the I-10/SR-51/Loop 202 interchange, Mill Avenue, and the McClintock Road /Loop 101 interchange area.

Queue Diagram of Existing Conditions for Segment P:



Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).



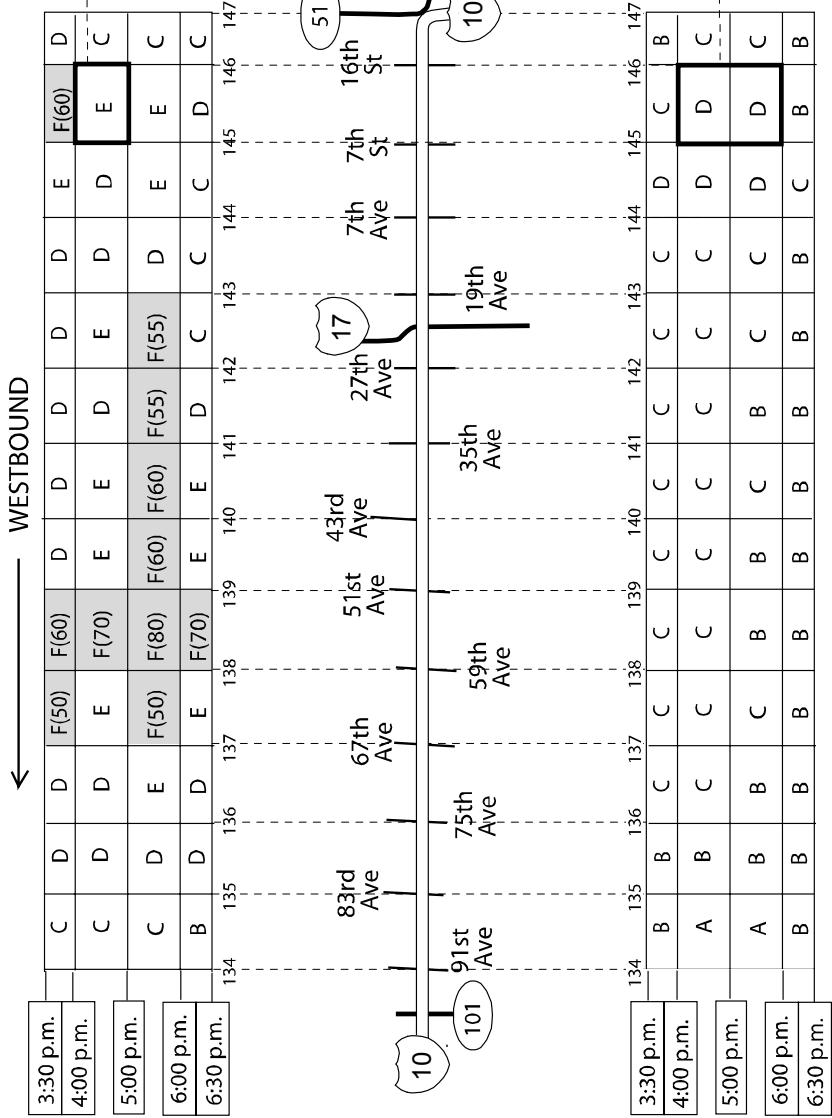
I-10

(Between 91st Ave & Loop 202 / SR 51)
Evening - Fall 2001

These level-of-service ratings represent the

mathematical average of densities, which varied from day-to-day

(congested/not congested); when congested, densities typically ranged between 55 and 45 pcplpm with corresponding speed estimates of 40 to 50 mph.



These level-of-service ratings represent the

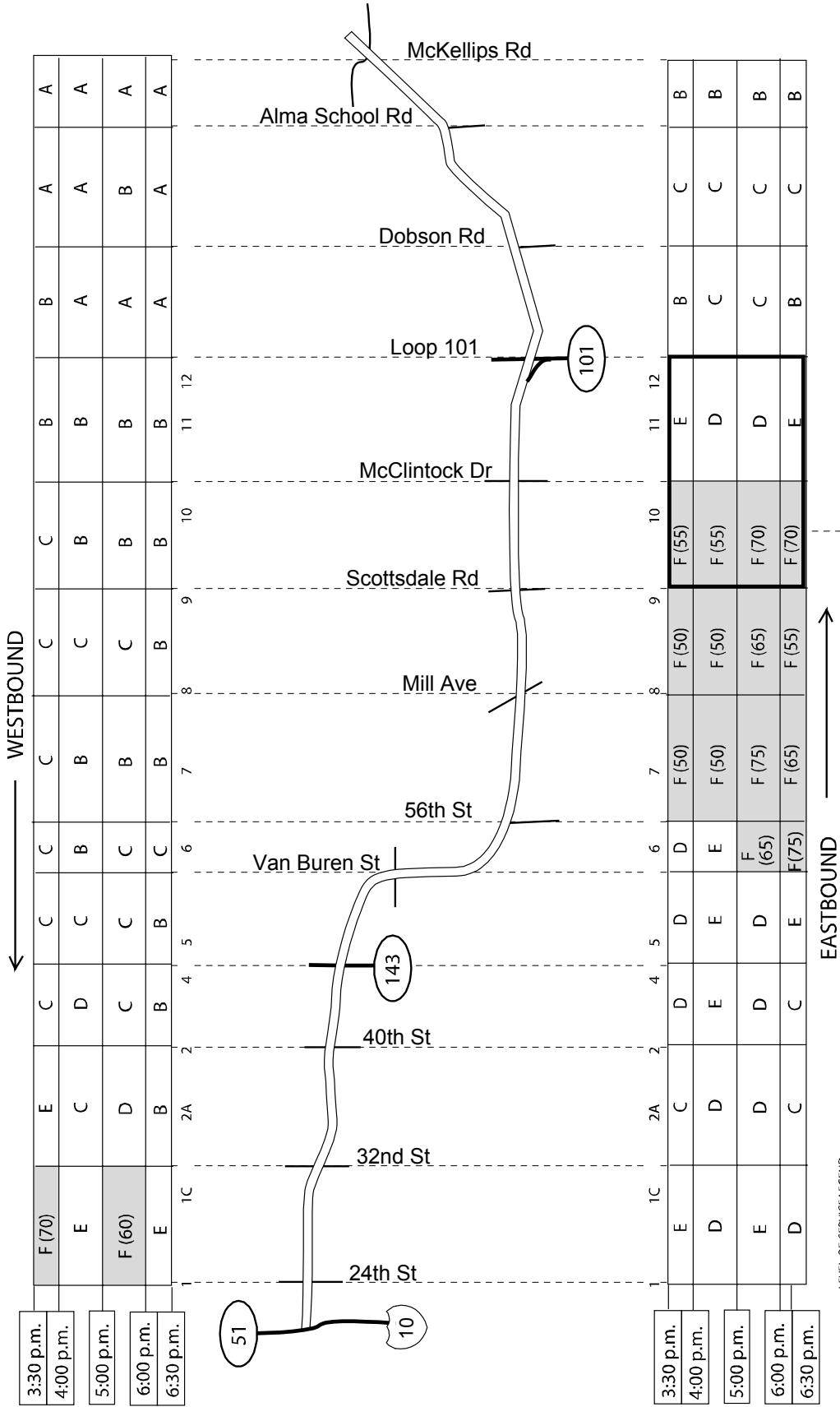
mathematical average of densities, which varied widely between right- and left-hand lanes. When congested, densities in the

right lane approaching the SR 51 / Loop 202/I-10 Interchange ranged between 55 and 45 pcplpm with corresponding speed estimates of 40 to 50 mph.

These level-of-service ratings represent the mathematical average of densities, which varied from day-to-day

LEVEL-OF-SERVICE LEGEND:					
LIGHT	MODERATE	HEAVY	CONGESTED	SEVERE	
0	10	20	30	45	65
A	B	C	D	E	F
0	10	20	30	45	65
Density scale (cars per lane-mile)					
Note: F (60) in the tables means level-of-service "F", with density = 60					

Loop 202 Evening - Fall 2001



LEVEL-OF-SERVICE LEGEND:

LIGHT	MODERATE	HEAVY	CONGESTED	SEVERE
A	B	C	D	F

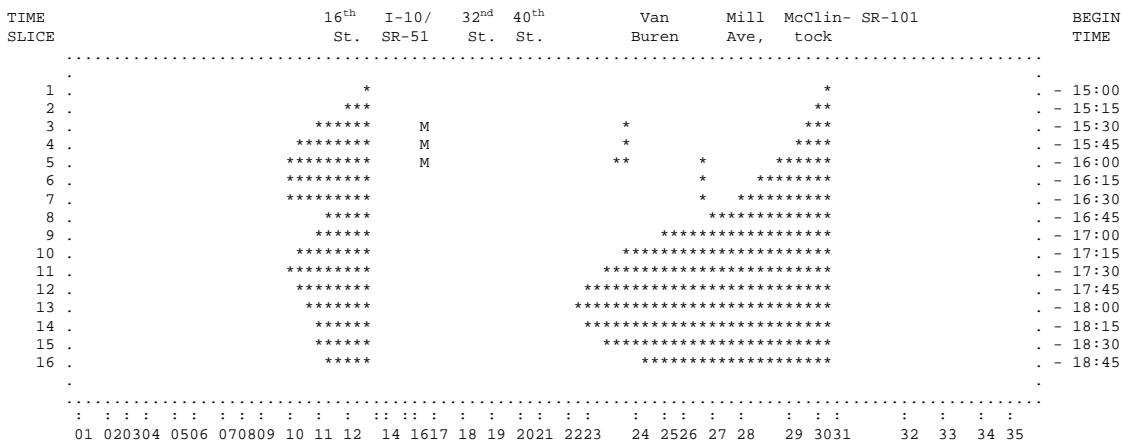
Density scale (cars per lane-mile)
Note: F (60) in the tables means level-of-service "F", with density = 60

These level-of-service ratings represent the mathematical average of densities, which varied widely between the right- and left-hand lanes. When congested, densities in the two right lanes approaching Loop 101 typically ranged from 100 to 60 pcplpm (peak period) with corresponding speed estimates of 15 to 30 mph.

Alternative1: Add auxiliary lanes at Mill Avenue and McClintock Road.

Result: This alternative reduces congestion at the Mill Avenue bottleneck, however, does not affect the downstream bottlenecks at McClintock Road and the Loop 202/Loop 101 interchange. Overall freeway travel time decreases 3%. Widening of Loop 202 in the vicinity of Loop 101 will be costly since the entire freeway is on structure.

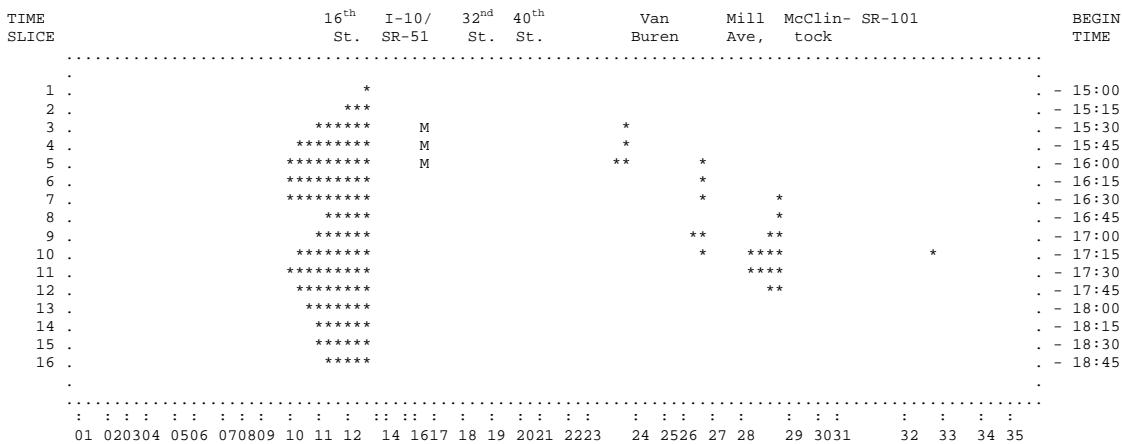
Queue Diagram of Alternative1 for Segment P:



Alternative2: At the Loop 101/Loop 202 interchange, make the Loop 101 off-ramp a two-lane mandatory off-ramp in addition to the auxiliary lanes added at Mill Avenue.

Result: This alternative significantly reduced congestion at Mill Avenue and the McClintock Drive/Loop 101 interchange. Overall, freeway travel time decreases 8%.

Queue Diagram of Alternative2 for Segment P:



Alternative3: Add a third lane to the I-10 to Loop 202 connector ramp.

Result: This alternative significantly reduced the congestion at the Loop 202 interchange, however, increased demand downstream produces added congestion at 24th Street, Mill Avenue, and McClintock Road/Loop 101. Overall freeway travel time decreases 2%.

Queue Diagram of Alternative3 for Segment P:

TIME SLICE	16 th St.	I-10/ SR-51	32 nd St.	40 th St.	Van Buren	Mill Ave,	McClin- tock	SR-101	BEGIN TIME
1 .	.	.	.	.	*	*	BB	.	- 15:00
2 .	**	.	*	*	BBB	BBB	*	.	- 15:15
3 .	***BB	.	***	**	BBBB	BBB	*	.	- 15:30
4 .	***BB	.	****	**	*****	BBB*	BBB*	.	- 15:45
5 .	*****BB	.	*****	*****	*****	BBBBB	BBB*	.	- 16:00
6 .	****	.	*****	*****	*****	BBBBBB	BBB*	.	- 16:15
7 .	*	.	*****	*****	*****	BBBBBB	BBB*	.	- 16:30
8 .	*****	.	*****	*****	*****	BBBBBB	BBB*	.	- 16:45
9 .	**	.	*****	*****	*****	BBBBBB	BBB*	.	- 17:00
10 .	**	.	*****	*****	*****	BBBBBB	BBB*	.	- 17:15
11 .	*	.	*****	*****	*****	BBBBBB	BBB*	.	- 17:30
12 .	*	.	*****	*****	*****	BBBBBB	BBB*	.	- 17:45
13 .	*	.	*****	*****	*****	BBBBBB	BBB*	.	- 18:00
14 .	*	.	*****	*****	*****	BBBBBB	BBB*	.	- 18:15
15 .	*	.	*****	*****	*****	BBBBBB	BBB*	.	- 18:30
16 .	*	.	*****	*****	*****	BBBBBB	BBB*	.	- 18:45
.
:	:	:	:	:	:	:	:	:	:
01 020304 0506 070809 10 11 12 14 1617 18 19 2021 2223 24 2526 27 28 29 3031 32 33 34 35									

Alternative4: At the Loop 101/Loop 202 interchange, make the Loop 101 off-ramp a two-lane mandatory off-ramp and include the auxiliary lanes at McClintock Road and at Mill Avenue as in Alternative 2. This also includes the I-10 interchange improvements in Alternative 3.

Result: This Alternative removes the delays, but would be a very costly improvement.

Queue Diagram of Alternative4 for segment P:

TIME SLICE	16 th St.	I-10/ SR-51	32 nd St.	40 th St.	Van Buren	Mill Ave,	McClin- tock	SR-101	BEGIN TIME
1	*	*	BB	.	- 15:00
2	BBB	BBB	*	.	- 15:15
3	BBBB	BBB	*	.	- 15:30
4	*****	BBB*	BBB*	.	- 15:45
5	*****	*****	BBB*	.	- 16:00
6	*****	*****	BBB*	.	- 16:15
7	*****	*****	BBB*	.	- 16:30
8	*****	*****	BBB*	.	- 16:45
9	*****	*****	BBB*	.	- 17:00
10	*****	*****	BBB*	.	- 17:15
11	*****	*****	BBB*	.	- 17:30
12	*****	*****	BBB*	.	- 17:45
13	*****	*****	BBB*	.	- 18:00
14	*****	*****	BBB*	.	- 18:15
15	*****	*****	BBB*	.	- 18:30
16	*****	*****	BBB*	.	- 18:45
.
:	:	:	:	:	:	:	:	:	:
01 020304 0506 070809 10 11 12 14 1617 18 19 2021 2223 24 2526 27 28 29 3031 32 33 34 35									

Analysis Summary – Segment P

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	22215	27378	49593	21.4
Alternative1	21468	27080	48549	22.3
Alternative2	14121	31372	45493	34.9
Alternative3	21153	27350	48503	22.6
Alternative4	10881	31959	42841	46.4

Conclusions/Recommendations:

1. Additional capacity is needed on the I-10 to Loop 202 connector ramp, the Loop 202 to Loop 101 connector ramp, and on Loop 202 between Mill Avenue and McClintock Road. Adding additional lanes to the connector ramps and auxiliary lanes between Mill Avenue and McClintock Road should be considered, although all of these segments are currently on structure.